SUMMARY REPORT FOR DATA COLLECTED UNDER THE SUPPLEMENTAL REMEDIAL INVESTIGATION QUALITY ASSURANCE PROJECT PLAN (SQAPP) FOR LIBBY, MONTANA

October 23, 2007

Prepared by
US Environmental Protection Agency
Region 8
Denver, CO

With Technical Assistance from:
Syracuse Research Corporation
Denver, CO

EPA, Reg 8
- Paul
- Mary
- Wendi

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EXECUTIVE SUMMARY

Introduction

In 2000, the U.S. Environmental Protection Agency Region 8 (EPA) began emergency response cleanup of residential and commercial properties at the Libby Asbestos Superfund Site in Lincoln County, Montana. The contaminant of concern is a form of asbestos referred to as "Libby Amphibole" (LA). Concurrent with emergency response cleanup, EPA has continued to investigate and evaluate the nature and extent of LA contamination at the Site, the magnitude of LA exposures occurring in Libby, and the efficacy of the emergency response cleanup program. As part of this on-going process, EPA developed a supplemental Remedial Investigation Quality Assurance and Project Plan (referred to as the "SQAPP") to guide the collection of data needed to help strengthen final decision-making at the site. The findings of the SQAPP investigation are summarized below.

Major Findings

1. Releases from Outdoor Soil to Air

When outdoor soil that contains LA is disturbed (e.g., by raking, mowing or digging), fibers are released into the breathing zone of the person who is causing the soil disturbance. The concentration of fibers that are released into the air is highly variable, both within and between differing types of disturbance activities, but there is a clear trend for levels in air to increase as the levels in soil (as measured by a polarized light microscopy method referred to as PLM-VE) increase. That is, the lowest average levels of LA in air are observed while disturbing soil that is non-detect (Bin A) by PLM-VE, with increasing average levels for soil that is < 0.2% (Bin B1), between 0.2% and 1% (Bin B2), or > 1% (Bin C). Because of the high variability in the levels measured in air at category of soil, EPA is currently working to collect additional data of this type to help strengthen the ability to quantify exposure of people to LA during outdoor activities that disturb soil in Libby.

2. Exposures in Indoor Air

Measurement of LA levels in indoor air of typical residences in Libby reveals that concentrations are usually higher in the breathing zone of residents (measured using personal air monitors) than in general room air (measured using stationary monitors), and that levels are generally higher when an individual is engaged in active behaviors (cleaning, sweeping, moving about) than in passive behaviors (sitting, reading, etc.). As was true for exposures in outdoor air, the levels seen in indoor air are highly variable, and EPA is currently collecting additional data to help quantify the average levels of LA that occur under both active and passive indoor behavior scenarios in Libby.

3. Dust as a Predictor of Indoor Air Exposures

EPA began with the assumption that the main source of LA in indoor air was likely to be contaminated indoor dust that was resuspended into indoor air by human activity or by mechanical forces (e.g., air flow from a furnace). However, paired measurements of indoor air and indoor dust collected during the SQAPP did not reveal any clear relationship. The basis for this apparent lack of correlation is not known. EPA is presently collecting additional data on levels of LA in indoor air and indoor dust in order to determine if a relationship can be detected.

4. Levels of LA in Outdoor Ambient Air

One exposure pathway that applies to all people in Libby is inhalation of outdoor ambient air. Prior to the SQAPP, a total of 404 outdoor ambient air samples had been collected, but most of these were not analyzed with an analytical sensitivity needed to provide an accurate estimate of the true concentration. Therefore, as part of the SQAPP, a sub-set of 33 of these samples was selected for supplemental analysis to achieve an analytical sensitivity that was about 25 times lower than the original sensitivity. Comparing the original results to the re-analyses indicated that the estimated mean value decreased about 2-fold (from 0.00055 s/cc to 0.00021 s/cc), and uncertainty around each value narrowed substantially. However, these air samples were not collected in a way that ensured they were spatially or temporally representative, so EPA is currently collecting additional outdoor ambient air samples to provide a clearer assessment of the exposure that may occur via this pathway.

Other Findings

1. Transfer of Soil into Indoor Dust

EPA generally assumes that outdoor soil is an important contributor to indoor dust. That is, if outdoor soil is contaminated with LA, any soil that is tracked into the house may contaminate the indoor environment. The amount of soil transferred from outdoors to indoors varies from site to site, so during the SQAPP, EPA collected data to help quantify this transfer process at Libby. The data collected suggested that the amount of soil transferred to indoor dust depends upon the condition of the yard and the number of people and pets entering/exiting the home on a regular basis. On average, the transfer factor was about 0.002 g soil/cm^2. However, this transfer factor yields predicted levels of LA in indoor dust that are substantially higher than measured levels, indicating that the factor should not be used to predict indoor dust levels until the basis of the discrepancy is resolved.

2. LA Levels in Soil that are ND by PLM

As noted above, EPA uses a polarized light microscopy method referred to as "PLM-VE" to estimate levels of LA in soil in Libby. This is a semi-quantitative method that reports a sample as non-detect (ND) when the microscopist can not recognize any LA in the sample. However, from the studies of outdoor soil disturbance (see above), it is evident that soils that are ND can release LA fibers to air. For this reason, EPA used more powerful electron microscopic methods to estimate the average level of LA in soils that were ND by PLM-VE. The results were variable between samples, but the average is approximately 0.05% by mass.

3. LA Levels in Dust Under Carpets

One source of potential concern to EPA is LA fibers that may be trapped under carpets. In order to obtain preliminary data, EPA sampled dust under 12 carpets in Libby. Of these, 8 did not contain detectable levels of LA (< 200 s/cm^2). Four of the samples did contain detectable levels of LA, with observed LA loadings ranging from 180 to 1,600 s/cm^2. These all occurred in carpets that were more than 10 years old. While the small amount of data collected from this pilot-scale investigation is too limited to draw firm conclusions, these results indicate that LA may occur in dust under some carpets, with an apparent tendency for levels to be higher for older carpets. The degree to which dust under carpets contributes to levels of LA in indoor air is not known, and more data would be needed to determine whether dust under carpets represents a significant residual source of LA in indoor air.

4. Time Trends in Air and Dust After Cleanup is Completed

EPA has taken action at many properties in Libby to remove indoor and outdoor sources of LA contamination. In order to determine if the cleanup remains effective over time, EPA collected indoor air and dust data for a period of up to 16 months following indoor cleanup at four properties. No upward time trends in dust were apparent, but an increase in LA concentrations in indoor air did occur in two homes at the 16 months time period. The reason for this apparent increase is not known. Additional long-term monitoring would be needed to provide information on whether potential re-contamination is occurring due to residual sources.

5. Releases to Air from EPA Cleanup Activities

EPA employs a range of strategies to minimize releases of asbestos during soil cleanup activities. In order to evaluate the effectiveness of these control strategies, EPA routinely collects samples of air from monitors placed around the perimeter of cleanup activities. In general, the detection frequency of LA in these samples is low, and there is an apparent tendency for the most recent values to be lower than the earliest values. This trend is suspected to be attributable to the fact that the level of contamination in soil and waste material was higher at the first locations that were addressed (the screening and export plants) than at the residential and commercial areas that are currently being addressed. However, analytical sensitivities for many of these perimeter air samples were too high to support reliable conclusions on the actual concentration values in the air. Therefore, as part of the SQAPP, 20 perimeter air samples were re-analyzed to obtain an analytical sensitivity that was about 5-fold lower than in the original samples. The mean concentration based on the re-analyses (0.0005 s/cc) is about 4-fold lower than was estimated previously for the same samples, and within a factor of about 2 of the average value in outdoor ambient air.

1 Introduction

In 2000, the U.S. Environmental Protection Agency Region 8 (EPA) began emergency response cleanup of residential and commercial properties at the Libby Asbestos Superfund Site in Lincoln County, Montana. Concurrent with emergency response cleanup, EPA has also continued to investigate and evaluate the nature and extent of asbestos contamination at the Site, the magnitude of asbestos exposures occurring in Libby, and the efficacy of the emergency response cleanup program. The intent of this on-going evaluation is to gauge the effectiveness of current cleanup practices, to provide the information necessary to improve cleanup efficiency, and to support the establishment of a final cleanup program for the Site. As part of this evaluation, EPA identified a number of uncertainties and data gaps that required further investigation, and developed a supplemental Remedial Investigation Quality Assurance and Project Plan (referred to as the "SQAPP") to guide the collection of additional data needed to help strengthen final decision-making at the Site (EPA 2005). Twelve areas of investigation were identified in the SQAPP, including:

Task 1: Estimation of Soil Contribution to Indoor Dust
Task 2: Estimation of Indoor Dust K-Factors
Task 3: Estimation of K-Factors for Outdoor Exposure Scenarios
Task 4: Detection Limits for Soil Methods
Task 5: Concentration in Soil that is ND by PLM-VE
Task 6-9: Time Trends in Asbestos Levels in Air and Dust in Remediated Buildings
Task 10: Dust Concentrations Under Carpets
Task 11: Safety Factor
Task 12: Re-analysis of Ambient Air and Perimeter Air Samples

The first group of tasks (Tasks 1-5) was mainly designed to help improve EPA's ability to evaluate human exposure to asbestos in the home and residential environment. The second group of tasks (Tasks 6-12) was mainly designed to help evaluate the efficacy of EPA's cleanup activities.

The purpose of this report is to summarize the data collected during each SQAPP task and provide an interpretation of the findings.

2 Data Management

2.1 Sample Documentation, Handling, and Custody

All air, dust, and soil samples collected as part of the SQAPP were identified with index identification numbers (Index IDs) assigned a prefix of "SQ" (e.g., SQ-00001). Data on the sample type, location, collection method, and collection time of all samples were recorded both in a field log book maintained by the field sampling team and on a field sample data sheet (FSDS) designed to facilitate data entry into the site database (see below). Hard copies of all FSDSs and field log books generated during the SQAPP sampling events are stored in the CDM field office in Libby, MT and at the John A. Volpe National Transportation Systems Center (Volpe Center) in Cambridge, MA. All samples collected in the field were maintained under chain of custody during sample handling, preparation, shipment, and analysis.

2.2 Database Management

Sample and analytical data are stored and maintained in a site database (referred to as the Libby2DB) housed on a SQL server at the EPA Region 8 facility in Denver, Colorado. Raw data for all SQAPP samples summarized in this report were downloaded on April 17, 2007 into a Microsoft Access® database by SRC, unless specified otherwise. A copy of this Access database is provided in Appendix 2.1 of this report (provided electronically on the attached CD). Any changes made to the Libby2DB since this download will not be reflected in the Access database.

2.3 Data Verification

In order to ensure that the Libby2DB accurately reflects the original hard copy documentation, all data downloaded from the database were examined to identify data omissions, unexpected values, or apparent inconsistencies. In addition, a subset of all FSDSs and analytical results were selected for detailed verification. In brief, verification involves comparing the data for a sample in the Libby2DB to information on the original FSDS form and on the original analytical bench sheets for that sample. Table 2-1 summarizes the fraction of the SQAPP data that has been verified stratified by task.

Appendix 2.2 provides a detailed description of any omissions or apparent errors that were noted, along with the actions taken to rectify these issues for the purposes of summarizing and interpreting data for this report. It is anticipated that these issues will be addressed and corrected in future downloads of the Libby2DB. All tables and figures generated for this report reflect corrected data.

3 Analysis Methods and Data Reduction

3.1 Transmission Electron Microscopy (TEM)

Air and dust samples collected as part of the SQAPP were analyzed by transmission electron microscopy (TEM) in basic accord with the method and counting rules specified in ISO 10312 (ISO 1995), and the SQAPP-specific counting rule modifications (specified in Appendix E of the SQAPP). This modification included changing the recording rule to include structures with an aspect ratio ≥ 3:1. The medium and task-specific target sensitivities for TEM were specified in Appendix B of the SQAPP.

When a sample is analyzed by TEM, the analyst evaluates multiple grid openings to support analytical sensitivity requirements and records the size, shape, and mineral type of each individual asbestos structure that is observed. Mineral type is determined by Selected Area Electron Diffraction (SAED) and Energy Dispersive Spectroscopy (EDS), and each structure is assigned to one of the following four categories:

LA Libby-class amphibole. Structures having an amphibole SAED pattern and an elemental composition similar to the range of fiber types observed in ores from the Libby mine (Meeker et al. 2003). This is a sodic tremolitic solid solution series of minerals including actinolite, tremolite, winchite, and richterite, with lower amounts of magnesio-arfedsonite and edenite/ferro-edenite.

OA Other amphibole-type asbestos fibers. Structures having an amphibole SAED pattern and an elemental composition that is not similar to fibers types from the Libby mine. Examples include crocidolite, amosite, and anthophyllite. There is presently no evidence that these fibers are associated with the Libby mine.

C Chrysotile fibers. Structures having a serpentine SAED pattern and an elemental composition characteristic of chrysotile. There is presently no evidence that these fibers are associated with the Libby mine.

NAM Non-asbestos material. These may include non-asbestos mineral fibers such as gypsum, glass, or clay, and may also include various types of organic and synthetic fibers derived from carpets, hair, etc.

For the purposes of this report, air concentrations and dust loading values are based on total countable LA structures only.

3.1.1 Calculation of Air Concentration and Dust Loading Values

The concentration of air concentration or dust loading of asbestos structures is given as:

Air Concentration (s/cc) or Dust Loading (s/cm^2) = N · S

where:

N = Number of structures observed
S = Sensitivity (1/cc for air or 1/cm^2 for dust)

The calculation of the sample sensitivity depends upon the media analyzed (air or dust). For air, the sensitivity is calculated as:

$$S = \frac{EFA}{GO \cdot A_{go} \cdot V \cdot 1000 \cdot F}$$

where:

S	=	Sensitivity in air (cc^{-1})
EFA	=	Effective area of the filter (mm^2)
GO	=	Number of grid openings examined
Ago	=	Area of a grid opening (mm^2)
V	=	Volume of air passed through the filter (L)
1000	=	Conversion factor (cc/L)
F	=	Fraction of primary filter deposited on secondary filter (indirect preparation only)

For dust, the sensitivity is calculated as:

$$S = \frac{EFA}{GO \cdot A_{go} \cdot SA \cdot F}$$

where:

S	=	Sensitivity in dust (cm^{-2})
N	=	Number of structures observed
EFA	=	Effective area of the filter (mm^2)
GO	=	Number of grid openings examined
Ago	=	Area of a grid opening (mm^2)
SA	=	Area of surface collection (cm^2)
F	=	Fraction of primary filter deposited on secondary filter

3.1.2 Combining Results from Multiple Analyses of a Single Sample

In some instances, the same air or dust sample was analyzed more than one time by TEM. In most cases, the second analysis simply evaluated additional grid openings to improve analytical sensitivity for the sample. Therefore, if an air or dust sample was analyzed more than once by TEM, each analysis result was combined together to represent a single "pooled" result value that collapses across all TEM analyses. As discussed in Appendix 3.1, the pooled result was calculated as follows:

Pooled Result = $\sum N_i / \sum (1/S_i)$

where:

N_i = Number of structures for analysis 'i'
S_i = Analytical sensitivity for analysis 'i' (cc^{-1} for air, cm^{-2} for dust)

3.1.3 Combining Results from Multiple Samples

When the exposure metric of concern is the average concentration across a set of multiple samples, the best estimate of the mean concentration is calculated simply by averaging the individual concentration values. As discussed in Appendix 3.1, samples with a count of zero (and hence a concentration of zero) are evaluated as zero when computing the best estimate of the mean.

3.1.4 Estimating Upper and Lower Confidence Bounds

For an Individual Sample

The uncertainty around a TEM estimate of asbestos concentration in a sample is a function of the number of structures observed during the analysis. The 95% confidence interval around the concentration is given by:

$$LB = \frac{1}{2} \cdot CHIINV[0.975, (2 \cdot N+1)]$$
$$UB = \frac{1}{2} \cdot CHIINV[0.025, (2 \cdot N+1)]$$

where:

LB = lower bound on the confidence interval
UB = Upper bound on the confidence interval
CHIINV = Inverse chi-squared cumulative distribution function
N = Number of structures observed

As illustrated in Table 3-1, as N increases, the absolute width of the confidence interval increases, but the relative uncertainty [expressed as the confidence interval (CI) divided by the observed value (N)] decreases.

Using this approach, the equation for calculation of the upper and lower bounds on the air concentration or dust loading of asbestos structures is:

Air Concentration (s/cc) or Dust Loading (s/cm^2) = (LB or UB) $\cdot$ S

where:

LB or UB = Number of structures based on lower bound (LB) or upper bound (UB)
S = Sensitivity (cc^{-1} for air or cm^{-2} for dust)

Across Multiple Samples

When a set of samples is collected from an exposure area in which concentration varies over space or time, the resulting data values include the between-sample variability that arises from both analytical measurement error in individual samples and from between-sample temporal or spatial variability. As discussed in Appendix 3.1, the mathematics of computing the 95% upper confidence limit (UCL) of the mean for this type of data is not well established, and no method is currently approved for use at Libby. Therefore, in this report, no uncertainty bounds are provided for mean values, but it is important to recognize that the values are uncertain. EPA will characterize the uncertainty around mean values after a statistical approach is established.

3.2 Polarized Light Microscopy (PLM)

Soil samples collected as part of the SQAPP were prepared in accord with the CDM Close Support Facility (CSF) Soil Preparation Plan (SPP) (CDM 2004). In brief, each soil sample is dried and sieved through a ¼ inch screen. Particles retained on the screen (if any) are referred to as the coarse fraction. Particles passing through the screen are referred to as the fine fraction, and this fraction is ground by passing it through a plate grinder. The resulting material is referred to as the fine ground fraction. Coarse fraction soil aliquots are examined using stereomicroscopy, and any particles of asbestos (confirmed by polarized light microscopy, or PLM) are removed and weighed in accord with SRC-LIBBY-01 (referred to as "PLM-Grav"). Fine ground fraction aliquots are analyzed using a Libby-specific PLM visual area estimation method (SRC-LIBBY-03, referred to as "PLM-VE").

PLM-VE is a semi-quantitative method that utilizes site-specific reference materials to allow assignment of samples into one of four "bins", as follows:

- *Bin A (ND):* non-detect
- *Bin B1 (Trace):* detected at levels lower than the 0.2% reference material
- *Bin B2 (<1%):* detected at levels lower than the 1% reference material but higher than the 0.2% reference material
- *Bin C:* detected at levels greater than or equal to 1%

Of the 75 soil field samples collected during the SQAPP investigation, only 5 had a coarse fraction, and all of these samples were reported as non-detect for LA when analyzed by PLM-Grav. Because of this, this report focuses on the PLM-VE results for the fine fraction.

4 Quality Control Summary

A number of Quality Control (QC) samples were collected as part of the SQAPP investigation to help characterize the accuracy and precision of the data obtained. QC samples included both field-based samples (which are submitted blind to the laboratories) and laboratory-based samples.

4.1 Field QC Samples

4.1.1 Field Blanks

A field blank is a filter cassette for either a personal or a stationary air monitor or a dust microvacuum, through which no air is drawn. Field blank samples for air are prepared for TEM analysis using a direct preparation, while field blank samples for dust are prepared using an indirect preparation. There is no field blank for soil.

For SQAPP tasks associated with activity-based sampling (ABS) (Tasks 2 and 3), field blanks for air and dust were collected at a rate of one per activity scenario. Approximately 10% of the field blanks collected during ABS were analyzed by TEM. The field blanks selected for analysis ranged over the length of the project and over expected soil concentration ranges. For SQAPP tasks not associated with ABS, field blanks for air and dust were collected at a rate of one per sampling team per day. One field blank per task per day was submitted for TEM analysis.

A total of 159 air field blanks and 40 dust field blanks were collected. Of these, 44 air field blanks and 13 dust field blanks were analyzed by TEM. The remaining field blanks were archived. Appendix 4.1 provides the detailed sample, analysis, and results information for each field blank.

No asbestos structures were observed in any of the analyzed field blank samples; therefore, additional analysis of archived field blanks was not necessary. This demonstrates that filter contamination due from either field or laboratory sources is not expected to influence asbestos results for samples collected as part of the SQAPP sampling activities.

4.1.2 Field Duplicates/Replicates

A field duplicate/replicate is an independent sample of environmental medium collected at the same place and at the same time as the primary sample. For soil, field "duplicates" are actually splits of the original field sample taken after field homogenization of soil. Field duplicates for soil were collected at a rate of about 1 field duplicate per 20 field samples in accordance with the frequencies specified in the SQAPP, resulting in three field duplicates (out of 75 field samples). For air, when feasible, side-by-side air pumping systems (co-located samples) were placed to gauge the reproducibility of results. The SQAPP did not specify a target collection rate for air field replicates, but 10 co-located pairs were collected (out of 311 field samples).

Table 4-1 summarizes the results of the original and duplicate samples for surface soil (Panel A) and stationary air (Panel B).

For soil, field duplicate results are ranked as concordant if both the original sample result and the field duplicate result report the same semi-quantitative classification. Results are ranked as weakly discordant if the original sample result and the field duplicate result differed by one semi-quantitative classification (e.g., Bin A vs. Bin B1). Results are ranked as strongly discordant if the original sample result and the field duplicate result differed by more than one semi-quantitative classification (e.g., Bin A vs. Bin B2). As seen, all three of the primary samples were Bin A (ND), and two of the three field duplicates were also Bin A (ND). One of the field duplicates was ranked as Bin B1 (<0.2%), which corresponds to a weak discordance with the parent sample. This discordance may be due to analytical variability, but might also arise from authentic heterogeneity between the soil samples. Because only three soil field duplicates were collected as part of the SQAPP, the number of samples is too limited to draw firm conclusions regarding reproducibility. However, the data suggest that results will generally be similar although differences due to small scale heterogeneity in the samples may occur.

For air, the original and replicate results were compared using a statistical test that compares the ratio of the two concentrations, each expressed as a Poisson rate (count/volume), as recommended by Nelson (1982). As seen, there was no statistically significant difference in concentration between any pair of original and replicate air samples. These results indicate that there is good reproducibility between field replicate samples for air, and that results of SQAPP investigations of air samples are suitable for use in exposure assessment and decision-making.

4.2 Laboratory QC Samples

4.2.1 TEM Laboratory Blanks

A laboratory blank for TEM is a grid that is prepared from a new, un-used filter by the laboratory and is analyzed using the same procedure as used for field samples. The purpose of the laboratory blank is to determine if there are any significant sources of contamination arising during sample preparation or analysis in the laboratory. As specified in Libby laboratory modification LB-000029, laboratory blanks are to be analyzed at a frequency of 4%.

A total of 23 TEM laboratory blanks have been analyzed as part of the SQAPP investigation (out of 399 TEM analyses). This corresponds to an analysis frequency of about 5.8%. Appendix 4.2 provides the detailed analysis and results information for each laboratory blank.

No asbestos structures were observed on any laboratory blank sample. Based on these results, it is concluded that sample preparation and analysis procedures utilized within the analytical laboratories did not introduce asbestos contamination.

4.2.2 TEM Recounts

A recount analysis is a re-examination of the original TEM grid openings to verify observed structure counts and characteristics. The following types of recount analyses were performed by each of the participating analytical laboratories during TEM analysis of SQAPP samples:

Recount Same (RS) – This is a TEM grid that is re-examined by the same microscopist who performed the initial examination.

Recount Different (RD) – This is a TEM grid that is re-examined by a different microscopist than who performed the initial examination.

Verified Analysis (VA) – This is similar to a Recount Different but has different requirements with regard to documentation. A verified analysis must be recorded in accord with the protocol provided in NIST (1994).

Interlab (IL) – This is a TEM grid that is re-examined by a microscopist from a different laboratory than who performed the initial examination.

Recount analyses were compared with the original analysis on a grid opening-by-grid opening and structure-by-structure basis. Only those grid openings that were able to be re-examined during the recount analysis were included in this evaluation. Three metrices were evaluated to assess the degree of agreement (concordance) between the original analysis and the recount analysis: 1) total number of countable asbestos structures observed, 2) mineral class designation (LA, OA and C), and 3) structure dimensions (length, width). Specific concordance criteria are detailed in Libby laboratory modification LB-000029.

A detailed concordance analysis based on mineral type and structure dimension of individual structures was performed based on presumptive matches of individual structures. For example, if a single structure is observed in a particular grid opening in both the original and the recount analysis, and the dimensions of the structure are similar in each analysis, it may be presumed that the structure being recorded is the same. Conversely, when a structure is observed in one analysis (either the original or the recount) but not the other, or if the dimensions of a structure are clearly dissimilar between the original and the recount, the structure that is observed is classified as "mis-matched".

A total of 3 RS, 5 RD, 4 VA, and 2 IL analyses have been performed as part of the SQAPP investigation. For these recount analyses, a total of 261 grid openings were re-examined. Of these, one or more asbestos structures were observed in either the original and/or the recount analysis in 32 of the grid openings. In these 32 grid openings, a total of 69 unique asbestos structures were observed. Tables 4-2 and 4-3 present the detailed grid opening-specific and structure-specific comparisons, respectively.

The grid opening-specific comparison (Table 4-2), which is based on the total number of structures counted in each grid opening, showed that differences in structure counts did not occur when grid openings were re-examined within the same laboratory. However, differences in structure counts did occur when the re-examination was performed by a different laboratory (i.e., interlab). The average of the absolute difference in the grid opening structure count for interlab analyses compared to the original analysis was about 1.2 structures, and the average difference was about -0.1 structures. There does not appear to be a tendency for more/less structures to be recorded in either the original or recount analysis. The number of interlab analyses performed for the SQAPP is too limited to determine if there are laboratory-specific differences. The total structure counts across all matched grid openings were compared using a statistical test that compares the Poisson rate (count/total grid openings), as recommended by Nelson (1982). Differences in total structure counts across all grid openings between the original laboratory and the interlab within a sample were not statistically different for either interlab analysis.

The structure-specific comparison (Table 4-3) showed similar results, with high concordance in recorded structure attributes within the same laboratory, and lesser concordance across laboratories. When matched structures were ranked as discordant, it was always due to differences in length. The average of the absolute difference in recorded length was about 2.8 um, and the average difference was about +0.03 um. In most instances where length discordances were noted, structures are representative of fibers protruding from matrices. It is possible that differences in recorded lengths are due to differences in how fiber lengths were estimated when fiber ends were obscured/overlapped by matrix particles. It is also possible that differences could be due to methods in measuring length (i.e., direct measurement vs. measurement as screen length). No discordances in mineral class or width were noted.

These results suggest that there is generally good agreement between analysts within a laboratory, but there may be some differences in analysis methods and recording procedures between laboratories. These differences are generally small and are not expected to influence the usability and interpretation of the SQAPP results.

4.2.3 TEM Repreparations

A repreparation by TEM is a grid that is prepared from a new aliquot of the same field sample filter as was used to prepare the original grid. Repreparation analyses are compared to the original analysis based on the Poisson rate ratio method recommended by Nelson (1982).

Repreparations were prepared for 2 dust samples and 3 air samples as part of the SQAPP investigation. Table 4-4 summarizes the results of both the original analysis and the repreparation analysis. As seen, with the exception of one sample (SQ-00321), the asbestos levels reported in the repreparation analysis were not statistically different than the original analysis. The basis for the apparent difference for sample SQ-00321 (original estimate = 0.69 f/cc, repreparation estimate = 0.18 f/cc) is not known. Note, however, that a statistical test of this type is expected to have about a 5% probability of identifying a pair as different even when there is actually no difference.

4.2.4 PLM-VE Laboratory Duplicates

For PLM-VE, a laboratory duplicate is a re-preparation of a soil sample slide by a different analyst than who performed the original analysis. Laboratory duplicate results are ranked as concordant if both the original sample result and the laboratory duplicate result report the same semi-quantitative classification. Results are ranked as weakly discordant if the original sample result and the laboratory duplicate result differed by one semi-quantitative classification (e.g.., Bin A vs. Bin B1). Results are ranked as strongly discordant if the original sample result and the laboratory duplicate result differed by more than one semi-quantitative classification (e.g., Bin A vs. Bin B2).

Table 4-5 summarizes the original and laboratory duplicate results for PLM-VE. As seen, in all instances, both the original sample result and the laboratory duplicate result were ranked as concordant. These results support the conclusion that the soil sample results for PLM-VE are reproducible and reliable and are not greatly influenced by differences in laboratory analysis techniques between analysts.

4.3 Conclusions

Based on the QC data reviewed above, it is concluded that:

- Inadvertent contamination of air or dust field samples with LA or other forms of asbestos is not of significant concern, either in the field or the laboratory.

- TEM analytical precision is generally good, as indicated by high agreement rates between field samples and matched field replicates, and between original and re-preparation samples.

- In TEM recount analyses (i.e., samples where the same grid openings are evaluated twice), there is generally high agreement for recounts performed within the same laboratory (either by the same analyst or different analysts), with somewhat lower agreement for interlab analyses. These results suggest that there may be some differences in methods or procedures between laboratories.

- PLM analytical precision is generally good, as indicated by high concordance rates between field samples and matched field duplicates and laboratory duplicates.

Taken together, these results indicate that TEM and PLM data collected at the Libby site as part of the SQAPP investigation are of acceptable quality, and are considered to be reliable and appropriate for use without qualification.

5 Task 1: Estimation of Soil Contribution to Indoor Dust

Exposure to indoor dust that is contaminated with asbestos is a potentially important exposure pathway for residents. This is because most people spend a large fraction of time indoors, and a wide variety of routine and indoor activities may cause the asbestos in dust to become suspended in air where it can be inhaled into the lung.

One potential source of asbestos contamination in indoor dust is asbestos in outdoor soil. EPA typically assumes that about 70% of indoor dust is derived by transport of outdoor soil inside the home, although this may vary from site to site. At Libby, the potential role of outdoor soil as a source of LA in indoor dust is supported by an analysis of available soil and dust data which suggests that the presence of detectable levels of LA in outdoor soil is correlated with an increased detection frequency and average level of LA in indoor dust (EPA 2007a).

Because of the potential importance of exposure to soil-derived asbestos in dust, it is important to understand the relationship between the concentration of asbestos in outdoor soil and the resultant concentration of asbestos in indoor dust. This relationship is expressed as:

$$C(\text{dust}) = C(\text{soil}) \cdot Ksd$$

where:

C(dust) = concentration (loading) of asbestos particles in indoor dust (s/cm^2)
C(soil) = concentration of asbestos structures in soil (s/gram)
Ksd = soil to dust transfer coefficient (g soil/cm^2)

In order to obtain site-specific data on the value of Ksd, Task 1 of the SQAPP called for measurements of Ksd in multiple homes in Libby to help increase confidence in risk estimates for exposure to asbestos in indoor dust derived from contaminated outdoor soil.

5.1 Study Design

5.1.1 Conceptual Approach

One approach for quantifying Ksd is to measure asbestos levels in both C(dust) and C(soil) at a location (e.g., a residence) and calculate the ratio for that location. It is important to note that Ksd is expected to vary from location to location, so the results combined across many different locations should be thought of as a distribution rather than a single value. One limitation to this approach is that it assumes that soil is the only source of asbestos in indoor dust. In cases where other sources exist (e.g., releases from indoor vermiculite insulation), the concentration of asbestos in indoor dust will be higher than expected based on soil transport alone and will yield estimates of Ksd that are too high. One way to address this problem is to create a graph that plots C(dust) vs. C(soil) at many different locations, and use the slope of the best fit regression line as the estimate of the average value of Ksd. However, it is difficult to estimate the range of variability in Ksd between different homes because the fraction of the variability contributed by non-soil sources is not known.

An alternative approach for estimating Ksd is to select a non-asbestos chemical marker in soil that is not expected to have any significant source in indoor dust other than soil transport. In this approach, Ksd is calculated as follows:

$$\text{Ksd} = [\text{C(dust)} \cdot \text{M}] / [\text{A} \cdot \text{C(soil)}]$$

where:

Ksd = soil to dust transfer coefficient (g soil/cm^2)
C(dust) = concentration of non-asbestos chemical in indoor dust (ug/g dust)
M = Mass of dust collected (g)
A = Area vacuumed (cm^2)
C(soil) = concentration of non-asbestos chemical in soil (ug/g soil)

One potential limitation of this approach is that there is an implicit assumption that the transport of asbestos fibers in soil will be similar to the transport of the non-asbestos marker chemical in soil particles. Because of the differences in physical attributes of asbestos fibers and soil particles, this assumption is a source of uncertainty.

5.1.2 Number of Sampling Locations

As discussed in the SQAPP, screening level calculations suggested that if Ksd were measured at a set of 20 locations, it was likely that the mean and high-end value (e.g., 90^{th} or 95^{th} percentile) could be estimated with an error unlikely to be larger than about 2-fold. Based on this, paired soil and dust samples were collected from 20 homes in Libby, selected as described below.

5.1.3 Characteristics of Sampling Locations

The value of Ksd is expected to vary between locations for two main reasons: 1) the condition of the yard (bare soil *vs.* intact lawn), and 2) the number of "vectors" (i.e., the number of people, especially children, and the number of pets residing at a location) by which yard soil is brought into the house from outside. Therefore, in order to obtain a representative set of Ksd values, the sampling locations were stratified into four groups as follows:

Vegetative Cover Condition	Number of Vectors (a)	Number of Properties
Good (yard is mainly grass-covered)	≤ 3	5
	≥ 4	5
Poor (significant bare areas of soil are present)	≤ 3	5
	≥ 4	5

(a) A "vector" is any person (adult or child) or animal that enters and exits the home on a regular basis

Table 5-1 identifies the 20 locations that were selected for evaluation and indicates the number of vectors and vegetative cover conditions for each sampling location.

5.1.4 Soil Samples

In order to be representative, all soil samples were collected as a composite of 7-15 representative surface soil locations (depending on size of the area). Table 5-1 indicates the number of sub-samples composited for each soil sample. Soil was collected in basic accordance with SOP CDM-LIBBY-05.

Because it is believed that asbestos contamination is more likely to occur in certain types of outdoor soil locations (e.g., gardens) that in the yard as a whole, two separate soil composites were collected from most yards: specific use areas (SUAs) and non-specific use areas (referred to in this report as "yard" samples)[a]. These SUA and yard samples were prepared, analyzed, and maintained separately. Soil samples were dried and sieved in accord with the methods detailed in CDM (2004)[b].

5.1.5 Dust Samples

Dust samples were collected as a composite of multiple indoor locations, focusing on the main living areas. Because a dust mass of several grams is required for analysis of non-asbestos chemicals, dust collection was performed using a high-volume vacuum device, as described in SOP SRC-DUST-01. In order to obtain the quantity of dust necessary for analysis, the total area vacuumed was typically about 9 ft^2, ranging from 8-20 ft^2. Table 5-1 shows the area sampled for each dust sampling location.

5.1.6 Sample Analysis

All samples of soil and dust were analyzed for target analyte list (TAL) inorganic chemicals by SW-846 Method 6010B. As discussed in the SQAPP, it was originally planned that soil and dust samples would also be analyzed for LA asbestos by TEM in order to help judge if results for asbestos were substantially different than for other soil marker chemicals. However, it was later recognized that the high-volume dust collection method, which depends on a cyclone separator to recover dust particles from the vacuum air stream, would not be expected to yield a high recovery of asbestos particles in the dust fraction, since most asbestos particles are likely to be too small to be captured in the particulate matter. Therefore, this part of the planned sample analysis was not implemented.

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[a] SUA samples were not collected at five of the locations: 1004 Wisconsin Ave, 393 Farm to Market Rd, 3646 Highway 2 S, 500 Jay Effar Rd and 275 Dawson St. Two separate yard samples were collected at two of these locations, 500 Jay Effar Rd and 275 Dawson St; in these cases, the results for the two yard samples were averaged together.

[b] Several sieved soil samples were ground before TAL analysis, including 791 Flower Creek Rd, 250 Farm to Market Rd, 224 Forest Ave, 290 Granite Ave, and 393 Farm to Market Rd. This is not believed to have had any effect on the resulting concentration values.

5.2 Results

5.2.1 Raw Data

The raw analytical results for yard soils, SUA soils, and indoor dust samples are presented in Appendix 5.1 and are summarized in Table 5-2.

5.2.2 Selection of Chemical Markers: Detection Frequencies

The marker chemicals considered in this analysis were the list of TAL metals. As discussed in the SQAPP, high detection frequencies in both soil and dust are necessary for a meaningful quantitative determination of Ksd. As seen in Table 5-2, several of the metals had very low detection frequencies in both soil and dust, including antimony, beryllium, cadmium, selenium, silver, and thallium. Therefore, these metals were excluded as potential chemical markers. Further analyses were restricted to metals with high detection frequencies in both soil and dust, including arsenic, chromium, copper, lead, nickel, and zinc.

5.2.3 Yard vs. SUA Soil

As discussed previously, outdoor soils were separated into two categories: yard and SUA. In order to determine if the concentrations of metals in these two types of outdoor soils were similar (and should be combined) or dissimilar (and should be treated separately), paired samples (i.e., yard and SUA samples from the same property) were compared using the Wilcoxon signed rank test. Results from this test, shown in Table 5-3, indicate that there is no significant difference between the results for yard soils and SUA soils for the metals of interest. Therefore, the soil results for each yard were averaged across yard soil and SUA soil in order to improve the accuracy of the property-specific estimate.

5.2.4 Selection of Chemical Markers: Exogenous Sources

As discussed in the SQAPP, the most useful markers of soil transport to indoor dust are metals that do not have any significant indoor source. *A priori*, it is expected that there will be some household contributions of common metals (e.g., lead, copper) in some locations, but not necessarily all locations. As discussed in Appendix 5.2, Monte Carlo simulation was used to perform a screening level evaluation of the maximum dust/soil ratio that might be expected based on random variation in sample analysis, assuming that indoor dust was composed entirely of soil. Based on this analysis, sample pairs with dust/soil ratios higher than about 2.8 are very unlikely to arise unless there is an indoor dust source other than soil. Based on this, all data pairs with a dust/soil ratio greater than 2.8 were considered to be unreliable and were excluded from the calculation of Ksd. Figure 5-1 shows the dust data plotted against the combined soil data for the metals of interest, and identifies the data points identified as outliers ($C_{dust} > 2.8 \cdot C_{soil}$).

5.2.5 Ksd Results

The final data set used to calculate Ksd values, including dust and combined soil concentration data for each location, is shown in Appendix 5.3, along with the resulting location-specific value of Ksd. Table 5-4 summarizes the data by chemical, showing both the mean Ksd (g soil/cm^2) and the 95^{th} percentile of the Ksd values across locations. As seen, results are relatively similar across different chemical markers (typically in the range of 0.0015 to 0.0045 g soil/cm^2), suggesting that each is providing valid information on the distribution of Ksd values between sites. For this reason, the average of the means and the average of the 95^{th} percentile values across different chemicals are identified as the most robust and reliable estimates of the Ksd values for use in computing central tendency exposure (CTE) and Reasonable Maximum Exposure (RME), respectively.

5.2.6 Effect of Sampling Location Characteristics on Ksd

As discussed previously, the value of Ksd is expected to vary between locations based on the condition of the yard (bare soil *vs.* intact lawn) and the number of vectors by which yard soil is brought into the house from outside. Therefore, the sampling locations were stratified into four groups based on the vegetative cover condition (good *vs.* poor) and the number of potential "vectors" (≤ 3 *vs.* ≥ 4), where "vector" is any person (adult or child) or animal that enters and exits the home on a regular basis.

The Ksd results for each group were combined across all six indicator metals and compared pair-wise using a commercial statistical program (SigmaStat v2.0). Because the data failed a normality test ($p < 0.001$), they were analyzed using Kruskal-Wallis One Way ANOVA on Ranks. The results indicate that there is a significant difference in the distribution of Ksd estimates between groups ($p=0.004$). Specifically, the distribution of Ksd estimates from the group with good vegetative cover and ≤ 3 vectors is significantly different (lower) from the other groups ($p<0.05$). This finding is consistent with the expectation that soil transport into homes is reduced when the yard is in good condition (healthy grass cover) and there are few active pathways tending to bring soil into the home.

5.3 Reality Check

In order to investigate whether the values of Ksd derived as described above were likely to yield realistic estimates of LA loading in indoor dust, the average value (0.002 g soil/cm^2) was used to predict a range of indoor dust values based on PLM-VE soil values, and these predictions were compared to the average LA dust loading value observed in indoor spaces at each location. The basic equation for predicting the indoor loading is as follows:

$$\text{Cdust (predicted)} = (\text{Csoil}) \cdot \text{SPG} \cdot \text{Ksd} \qquad \text{(Equation 1)}$$

where:

Cdust = predicted LA loading in indoor dust (total LA structures/cm^2)
Csoil = Mass fraction of LA in outdoor yard soil (g LA per g of soil)

SPG = LA structures per gram of LA
Ksd = Soil to dust transfer factor (g soil per cm^2 indoor surface)

The value of SPG for LA in soil was estimated from particle size data obtained during TEM analysis of authentic site soils as part of the Performance Evaluation (PE) study. The mass of each LA structure observed in soil was estimated as follows:

$$\text{Mass (g)} = \text{length } (\mu m) \cdot \text{width}^2 (\mu m^2) \cdot 1\text{E-}12 \text{ cc}/\mu m^3 \cdot 3.1 \text{ g/cc}$$

The value for SPG was simply the total number of LA structures observed divided by the sum of the particle masses. The resulting value was 2E+11 TEM LA s/g.

Because values of Csoil that are derived from PLM-VE analysis are semi-quantitative, the following mass % ranges were assigned to each PLM-VE bin:

PLM-VE Bin	Range of Plausible Mass % Values		
	Lower Bound	Upper Bound	Best Estimate
A (ND)	0	0.05	0.01
B1 (Trace)	0.05	0.2	0.1
B2 (<1%)	0.2	1.0	0.5
C (≥ 1%)	Reported value - 0.5	Reported value + 0.5	Reported value

In cases where multiple PLM-VE samples exist for the same location, the mean concentration was estimated by taking the average of the best estimates. Similarly, the confidence bounds were estimated by taking the average of the lower bound values and upper bound values.

Because observed (measured) Cdust values are uncertain due to random statistical variability in the number of LA structures observed during analysis, each measured dust value was characterized as a range spanning the 90% Poisson CI around the reported value.

A prediction was ranked as passing the reality check if there was any overlap between the range of predicted dust values and the 90% Poisson CI around the observed dust value. Predictions that failed the reality check were ranked either as "too high" (the predicted range is higher than the upper bound of the observed value) or "too low" (the predicted range is lower than the lower bound of the observed value). The detailed results are provided in Appendix 5.4 and are summarized below.

Metric	PLM-VE BINS INCLUDED			
	All	B1, B2, C	B2, C	C
Total	717	136	20	1
Pass	437	0	0	0
Pass (%)	61%	0%	0%	0%
Too High	280	136	20	1
Too Low	0	0	0	0

As seen, a total of 717 locations were evaluated. If all of these locations are considered, 61% pass the reality check. However, this is potentially misleading, since all of the 437 values that passed were samples where the PLM-VE results for soil was Bin A (ND). As seen, if the analysis is restricted to locations where the soil was categorized as Bin B1 (trace, <0.2%), Bin B2 (<1%), and/or Bin C (≥1%), then the frequency of predicted dust values that pass the reality check is zero, and 100% of all predicted values are too high.

The basis for this discrepancy is not certain, but a number of factors might be involved:

- The calculation of indoor dust concentration assumes that the PLM-VE results for soil at a property are selected at random and the average of the measured values is a reliable estimate of the true yard-wide average (or at least the average of soil locations that contribute to indoor dust). However, many soil samples collected for analysis are from localized areas (e.g., gardens, other "special use areas") that may not be representative of the entire yard, and/or may not be the main sources of soil transport into indoor dust.

- The calculation of Ksd utilized site-specific data on the level of dust per unit area in the homes sampled. However, these dust samples were collected using a vacuum cleaner on carpets and rugs, so the amount of dust per unit area may substantially overestimate the amount of dust that is actually releasable into air and is relevant for risk assessment purposes.

- The use of Ksd based on metals to predict transport of asbestos assumes that there are no important differences in the transport pathways. However, as noted above, because of the differences in particle size and nature between asbestos fibers and soil particles, it is possible that there are differences. To the extent that Ksd based on metals overestimates transport of asbestos, it would be necessary to assume that asbestos particles are transported less efficiently into homes than soil particles. It is not known if such an assumption is reasonable or not.

In order to investigate if adjustments for one or more of these factors might bring the predicted results more nearly into agreement with the observed values, the equation for predicting dust levels was modified as follows:

$$\text{Cdust (predicted)} = \text{C(soil)} \cdot \text{SPG} \cdot \text{Ksd} \cdot \text{AF} \cdot \text{RF} \cdot \text{Kpt} \qquad \text{(Equation 2)}$$

where:

AF = Area fraction of the yard to which the PLM-VE result applies
RF = Fraction of dust in carpets that is releasable to indoor air
Kpt = Adjustment factor for preferential transport of soil compared to asbestos

No data are available on the value of any of these factors, so the following values were assumed based solely on professional judgment:

AF = 0.1
RF = 0.1
Kpt = 0.1

If these values are used, the frequency of predicted dust values passing the reality check improves, but the fraction of overestimates still exceeds the frequency of underestimates, suggesting that a significant discrepancy still remains:

Metric	BINS INCLUDED			
	All	B1, B2, C	B2, C	C
Total	717	136	20	1
Pass	685	116	6	0
Pass (%)	96%	85%	30%	0%
Too High	18	18	13	1
Too Low	14	2	1	0

This suggests that these factors account for some but probably not all of the apparent discrepancy. Another factor that might be contributing to this discrepancy is the value selected for SPG. An alternative source of SPG is from data on LA particle size data in air and dust (analyzed by TEM). The method for estimating SPG is the same as for soil. The resulting value is 3E+10 TEM LA s/g. If this lower value for SPG is combined with the assumed values for AF, RF, and Kpt, the predicted values begin to come into reasonable agreement with the observed values:

Metric	BINS INCLUDED			
	All	B1, B2, C	B2, C	C
Total	717	136	20	1
Pass	679	124	17	0
Pass (%)	95%	91%	85%	0%
Too High	2	2	1	1
Too Low	36	10	2	0

5.4 Conclusions

Measured values of Ksd at Libby range from 0.002 to 0.007 g soil/cm^2. However, screening level calculations indicate that use of a value of 0.002 g soil/cm^2 to predict indoor dust levels in accord with Equation 1 is likely to produce a large (approximately 10^4) overestimate of exposure to asbestos in indoor dust. If Equation 2 is used, predictions of indoor dust levels can be brought into approximate agreement with observations by assuming an overall correction factor of 0.0001. It is possible that a factor of this magnitude might arise from a combination of adjustments for spatial representativeness of the soil samples, the difference between total and releasable dust in carpets, differences in transport of asbestos and soil particles, and the number of structures of asbestos per gram of asbestos. However, there is at present no direct evidence to support any of the correction factors assumed.

6 Task 2: Estimation of Dust to Indoor Air Transfer

Once indoor dust becomes contaminated with asbestos, whether from outdoor soils or other means, the indoor dust may serve as a source of contamination of indoor air. If a relationship between asbestos levels in indoor dust and indoor air can be quantified, measurements of indoor dust concentrations could be used to predict concentrations in air that would result if the dust were disturbed, as follows:

$$C(air) = C(dust) \cdot Kda$$

where:

C(air) = Concentration of asbestos in air (s/cc) following disturbance of dust
C(dust) = Concentration (loading) of asbestos in dust (s/cm^2)
Kda = Release factor for dust to air (cm^{-1})

Note that the value of Kda is expected to be dependent on the nature of the activity occurring in the home, so no single value is expected to be appropriate for all situations. Rather, one value might be applicable to "routine" indoor activities, while another (presumably higher) value might be applicable to conditions when dust disturbance is high (e.g., during active cleaning activities).

Two different methods for estimating Kda at the Libby site were investigated, as described below.

Method 1

The most direct method to estimate Kda is to measure the concentration of LA in dust and air at a location, and calculate the ratio:

$$Kda = C(air) / C(dust)$$

Because this ratio can be highly variable because of variable conditions during indoor activities as well as random variability in sample analysis, the best way to estimate the average value of Ksd is to plot C(air) as a function of C(dust) and find the best fit linear regression line.

If the release of asbestos from dust to air were identical for all sizes of asbestos particle, the value of Ksd would not depend on the counting rules used to count asbestos structures in dust and air. However, in Libby, the release of asbestos particles from dust to air appears to be influenced by the particle size. As shown in Figure 6-1, the particle size distribution of LA structures found in air is enriched in larger (longer and thicker) structures than the LA structures found in dust. Because LA release from dust to air appears to depend on particle size, the value of Kda depends on which type of counting rules are used to express concentration in air and dust.

For the purposes of this effort, Kda is defined as the ratio of risk-based structures in air (PCME[c] s/cc) to the number of total TEM s/cm^2 in the source dust.

Method 2

A second method for estimating Kda is to measure the transfer of dust (rather than asbestos) from surfaces to air, and then correct that transfer factor to account for any preferential release of asbestos particles compared to dust particles. This is done as follows:

$$Kda = k\delta \cdot (k2 / k1)$$

where:

$k\delta$ = Surface to air transfer factor for dust (mg dust/cc in air per mg dust/cm^2 on surfaces)
k1 = risk-based structures (e.g., PCME) per total TEM structures in dust
k2 = risk-based structures (e.g., PCME) per total TEM structures in air

The potential advantage of this method compared to Method 1 is that the values of k1 and k2 are already known with good accuracy based on the consolidated set of LA particle size data available in Libby. The value of $k\delta$ can be estimated using real-time air particulate monitors (RAMs) to estimate dust loading in air and high volume vacuum samples to estimate dust loading on surfaces (SOP SRC-DUST-01):

$$k\delta = \text{Average dust concentration in air (mg/cc) / Average dust on surfaces (mg/cm}^2\text{)}$$

6.1 Data

6.1.1 Re-Analysis of Phase 2 Samples

During Phase 2 investigations at Libby performed in 2001 (EPA 2005), EPA collected a number of paired air and dust samples during two types of disturbance scenarios:

Scenario 1 (Routine Activity)

Scenario 1 focused on the airborne exposures of residents engaged in routine household activities (excluding active cleaning). Routine activities were performed by an adult resident with a personal air monitor worn at an adult breathing level (about 5-6 feet above the ground).

Scenario 2 (Active Cleaning)

Scenario 2 focused on active cleaning-related activities (vacuuming, sweeping, dusting) that are likely to cause increased levels of dust (and hence asbestos) in indoor air.

[c] PCM Equivalent (PCME) structures are defined as structures with length > 5 um, width ≥ 0.25 um, and aspect ratio ≥ 3:1.

Cleaning activities were performed by EPA personnel with a personal air monitor worn at an adult breathing level (about 5-6 feet above the ground).

In 2001, samples collected as part of the Phase 2 investigation were analyzed with an analytical sensitivity that was not adequate to allow reliable estimation of site-specific Kda factors (EPA 2005). Therefore, SQAPP Task 2A called for the re-analysis of both the air and dust samples from Scenario 1 (routine activity) and Scenario 2 (active cleaning) to achieve improved analytical sensitivity. Results following this re-analysis are presented below (see Section 6.2).

6.1.2 SQAPP Residential Scenario Sampling

Because the number of locations sampled as part of the Phase 2 investigation was limited, additional homes were selected as part of SQAPP Task 2B to evaluate air and dust during routine activities.

Sampling Locations

In concept, measures of dust in air and dust loading on surfaces could be collected at any representative set of homes in Libby. However, in order to be most valuable, a set of homes were selected for evaluation by both Method 1 and Method 2 simultaneously. This allows estimates of Kda estimated by Method 2 to be directly compared to estimates based on Method 1. Homes with previously measured dust levels of LA at least 1,000 s/cm^2 were preferentially selected to maximize the probability that results from Method 1 would yield reliable estimates of asbestos levels in dust and air.

Sample Collection and Analysis

For Method 1, air samples were collected under routine living conditions over a period of about 8 hours. A stationary air monitor was placed in the main living area of the home and a personal air monitor was worn by an adult resident at an adult breathing level (about 5-6 ft). Air samples were analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP.

Dust samples were composites collected using the microvacuum sampling method from approximately three 100-cm^2 template areas from horizontal surfaces and high traffic areas located in the main living space of the house. Dust samples were analyzed by TEM using ASTM counting rules. The target sensitivity for dust analysis was 20 cm^{-2}.

For Method 2, a stationary real-time air monitor (RAM) was used to measure the 8-hour average dust levels in air (ug/m^3) in the main living area of the home. A high volume dust vacuum was used to collect a composite dust sample from the same main living areas of the home. A high volume dust vacuum was needed to ensure that the mass of dust was large enough (1-2 grams) that it could be weighed with reasonable precision ($\pm$10 mg). The area vacuumed (cm^2) was also measured so that surficial dust loading (mg/cm^2) could be calculated.

6.2 Results for Method 1

Appendix 6.1 presents the detailed results for all air and dust samples collected or re-analyzed as part of the SQAPP indoor dust-to-air transfer investigation. Table 6-1 summarizes the LA results for dust and air samples from each property stratified by indoor activity scenario. In cases where more than one sample was collected for the media within the property (e.g., one dust sample from 1st floor, one dust sample from 2nd floor), results were averaged. Figure 6-2 presents a graphical summary of the personal and stationary air samples stratified by activity type and dust level. The upper panel of this figure presents the mean LA air concentrations for each property. The lower panel presents summary statistics across properties in a "box and whisker" format. In these figures, dust levels were stratified into three categories, as follows:

Low – LA levels in dust < 20 s/cm^2
Medium – LA levels in dust between 20-200 s/cm^2
High – LA levels in dust > 200 s/cm^2

As seen, average LA air concentrations associated with active cleaning activities tended to be higher than concentrations associated with routine activities, and average LA air concentrations from personal air monitors tended to be higher than concentrations from stationary air monitors. Within each group (e.g., routine personal, routine stationary, etc.), there is no observable trend between measured LA concentrations in air and measured LA levels in dust (i.e., increasing levels in dust do not appear to result in increasing levels in air).

The reason for this lack of observable correlation between dust and air is not certain, since it is generally expected that resuspension of indoor dust is the main source of LA in indoor air. One possible explanation for the apparent lack of correlation is that the relationship between dust levels and air levels is so highly variable and is so dependent on other factors that the relationship can not be detected until many more sample pairs are collected. Another possible explanation is that the dust samples collected from horizontal surfaces and high traffic areas may not be the main source of LA in indoor air, and that dust from other parts of the house (e.g., from upholstered furniture, air ducts, etc.) represents the main source. It is also possible that the range of dust levels evaluated in the indoor ABS scenarios was too narrow (only two properties had mean dust levels above 1,000 s/cm^2) for observable trends to be distinguished.

6.3 Results for Method 2

Table 6-2 summarizes the surficial dust loading and mean RAM dust levels measured at each location during routine activities, and these data are shown graphically in Figure 6-3. As seen, there is no apparent correlation between surficial dust loading and mean RAM dust levels measured in air. Indeed, the slope of the best fit regression line is not significantly different from zero ($p = 0.407$), and the strength of the correlation is very low ($R^2 = 0.05$). This indicates that it is not possible to reliably predict indoor dust levels in air as a function of indoor dust loading on surfaces. Thus, Method 2 does not appear to provide a reliable approach for estimating indoor exposure to asbestos in indoor air.

6.4 Conclusions

The primary purpose of SQAPP Task 2 was to investigate methods by which LA concentrations in indoor air might be estimated by measurements of LA in indoor dust (Method 1) or by measurements of total dust levels in indoor air (Method 2). In brief, neither method succeeded in providing a suitable method for predicting LA levels in indoor air. The reason for this is not certain, but could be due to limitations in the number and types of samples collected. EPA is presently performing additional studies to further investigate the relationship between indoor air and indoor dust.

7 Task 3: Estimation of Soil to Outdoor Air Transfer

Residents and workers may be exposed to asbestos in outdoor soil during a variety of different activities that disturb the soil and cause release of fibers from soil into the breathing zone of the person engaged in the soil disturbance activity. If a relationship between soil and breathing zone air can be quantified, measurements of asbestos concentration in soil can be used to predict concentrations in air if the soil is disturbed, as follows:

$$C(air) = C(soil) \cdot Ksa$$

where:

C(air) = Concentration of asbestos in air (s/cc) following disturbance of dust
C(soil) = Concentration of asbestos in soil (s/g)
Ksa = Release factor for soil to air (g soil/cc)

Note that Ksa is not expected to be a constant, but is expected to vary as a function of many variables, including the strength and nature of the disturbance activity, the condition of the soil, and the weather conditions during the disturbance. Thus, it is best to think of Ksa as a distribution of values rather than a single value.

One important limitation to this approach is that there are no well established methods for accurately measuring the concentration of asbestos in soil in units of s/g. While EPA has been investigating and testing SEM and TEM for this purpose, to date the most useful method for analyzing asbestos in soil has been the PLM-VE method. As noted above, this approach yields results in terms of mass percent, and is only semi-quantitative:

Bin A = None detected
Bin B1 = Detected at a level estimated to be < 0.2%
Bin B2 = Detected at a level estimated to be between 0.2 and 1%
Bin C = Detected at a level of 1% or greater

With this limitation in mind, the goal of Task 3 was to estimate the range of asbestos fibers in air as a function of the PLM-VE bin for soil where the outdoor activity-based sampling (ABS) scenario was occurring.

7.1 Data

7.1.1 Re-Analysis of Phase 2 Samples

During the Phase 2 project (EPA 2005), limited data were collected on the release of asbestos into outdoor air from active soil disturbance (rototilling a garden). This was referred to as Scenario 4. However, the samples of air were not analyzed with sufficient sensitivity to allow reliable characterization of asbestos levels in air. Therefore, SQAPP Task 3A called for the re-analysis of the air samples collected during Scenario 4 to achieve lower detection limits.

The original soil sample (a composite of four sub-locations within the garden) was analyzed by PLM in accordance with NIOSH 9002. Since the Phase 2 investigation, this PLM method has been refined (i.e., the site-specific PLM-VE method). As part of SQAPP Task 3A, the soil sample from the rototilled garden was re-analyzed by PLM-VE.

7.1.2 SQAPP Residential Scenario Sampling

In order to estimate human exposure from other types of outdoor activities, three standardized soil disturbance scenarios were evaluated as part of SQAPP Task 3B at multiple locations as described below. All outdoor ABS activities occurred in summer when soils were dry to maximize the potential for dust generation.

Child Playing in Dirt with a Shovel and Bucket

The first ABS scenario was designed to evaluate a child playing in an area of bare dirt. This activity included shoveling the bare dirt into a bucket with a toy shovel and then pouring the dirt back on the ground. The play activity was performed by EPA personnel sitting on the ground with a personal air monitor positioned at a height intended to represent the breathing zone of a sitting child (about 2 feet above the ground).

Raking of Bare Soil

The second ABS scenario was designed to evaluate disturbances due to raking the soil with a metal leaf rake. The activity was performed by EPA personnel with a personal air monitor at the breathing level of an adult (about 5-6 feet above the ground).

Lawn Mowing of Grass-Covered Soil

The third ABS scenario was designed to evaluate releases of soil particles (and hence asbestos particles) from grass-covered areas due to mowing the lawn with a gas-powered rotary lawn mower. This activity was performed by EPA personnel with a personal air monitor at the breathing level of an adult (about 5-6 feet above the ground). Because children may engage in lawn mowing activities in some cases, a second personal air monitor was also worn at a height expected for the breathing zone of an 8-12 year old child (about 3.5-4.5 feet).

Sampling Locations

In order to determine if a relationship exists between LA in soil and LA in outdoor air during soil disturbance scenarios, it is important that ABS be performed at locations that span a range of soil levels. This was achieved by selecting sampling locations based on available PLM data, as well as a number of locations where soil removal and replacement had occurred, as follows:

Soil Remediated?	Soil Conc. (PLM-VE)	Outdoor ABS Scenario		
		Digging in Dirt	Raking Bare Areas	Mowing Grassy Areas
Yes	Clean fill	6	6	6
No	Bin A (Non-Detect)	3	3	3
	Bin B1 (<0.2%)	3	3	3
	Bin B2 (0.2-<1%)	3	3	3
	Bin C (≥ 1%)	3	3	3

As seen, for each type of scenario, 3 to 6 locations were selected for each of the soil conditions, for a total of 18 locations per outdoor ABS scenario.

Sample Collection and Analysis

Air

For each scenario sampling event, two stationary air samples were collected – one placed 20-40 feet upwind of the activity location in an area not impacted by other dust-generating activities, and the other placed within 10 feet of the scenario location in a downwind direction. Two personal air samples were collected per worker, one at a high flow rate (about 10 L/min) and one at a lower flow rate (about 3-5 L/min). This was done to ensure that if the first filter became overloaded with debris, a second filter was available for analysis. In general, sampling occurred for a period of about 2 hours, generating an air volume of about 1,200 L for the high flow rate sample and about 400 L for the low flow rate sample.

All air samples from outdoor ABS scenarios were analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for air sample analysis was 0.001 $(cc)^{-1}$. In cases where samples were too overloaded with debris for direct analysis, an indirect analysis was performed.

RAM

Real-time air monitors (RAMs) were used to measure the dust levels in air (ug/m^3) during the scenario activity. One RAM was placed at the upwind location and one RAM was placed in the downwind location, co-located with the stationary air monitors.

Soil

One 10-point composite sample of soil was collected from each scenario area. Soils were collected at a depth of 0-2 inches in accord with SOP CDM-LIBBY-05, with modifications to accommodate the increase in sub-samples to achieve a total mass of soil large enough (2-3 kg total) to support any potential future tests and analyses. All soil samples were analyzed semi-quantitatively by PLM-VE.

7.1.3 Worker Scenarios

Like residents, workers may be exposed to soil in outdoor air as a result of various types of soil disturbance activities. The potential magnitude of these exposures was evaluated in the SQAPP for two cases, as follows:

Golf Course Workers

Workers at the local golf course may be exposed to asbestos fibers released from soil to air under two main types of activity: lawn mowing and soil aeration. To investigate the potential magnitude of these exposures, two personal air samples were collected per worker, one at a high flow rate and one at a lower flow rate. This was done to ensure that if the first filter became overloaded with debris, the second filter would be available. For this scenario, samples of soil were not collected because a sufficient number of soil samples from the golf course had already been evaluated as part of the Contaminant Screening Study and Phase 1 investigations.

EPA Cleanup Workers

There is an extensive database of personal air samples for EPA workers engaged in various types of remedial activities in and around Libby, including various soil clean-up actions in the main residential-commercial part of town. In general, TEM analyses of worker air samples were usually not carried out with sufficient sensitivity to allow reliable quantification of LA fiber concentrations in air. The SQAPP called for the re-analysis of existing personal air samples from EPA cleanup workers by TEM to achieve a lower (better) sensitivity. However, subsequent discussions with EPA determined that, because the types of activities performed and the locations where these activities were performed (and hence the LA levels in soil) cannot be derived with certainty from the existing EPA worker dataset, achieving better analytical sensitivities for these samples has only limited value in adding to an understanding of soil to air transfer. Therefore, the re-analysis of EPA worker samples was not implemented.

7.2 Results

7.2.1 Results for Phase 2 Rototilling

Table 7-1 summarizes the personal air and soil results for the Phase 2 rototilling samples that were selected for re-analysis under SQAPP Task 3A. As seen, LA air concentrations ranged from 0.029 s/cc for the rototiller assistant to 0.17 s/cc for the rototiller. LA levels in the garden soil sample were trace (Bin B1 - less than 0.2%) by PLM-VE.

Although limited, these results indicate that high intensity soil disturbance activities such as rototilling can result in relatively high LA concentrations in air, even when soils have LA levels that are below 0.2%.

7.2.2 Results for SQAPP ABS Sampling

Appendix 7.1 presents the detailed results for all samples collected as part of the SQAPP Task 3B outdoor ABS investigation. Table 7-2 summarizes the Task 3B results for each property by outdoor ABS scenario.

RAM Dust Data

During each outdoor ABS scenario, dust levels were measured at a RAM station upwind and downwind of the scenario activity at 5-minute time intervals throughout the duration of the activity. The right-hand columns in Table 7-2 present the upwind and downwind mean RAM dust levels for each location and ABS scenario. Inspection of these data reveal that, in general, the dust levels generated by the mowing scenario tends to be highest (mean = 70 ug/m^3), and the raking scenario (mean = 5.7 ug/m^3) and the playing scenario (mean = 6.3 ug/m^3) tend to be similar and somewhat lower.

It should be noted that ABS sampling occurred under conditions of relatively low wind speed, so the distinction between upwind and downwind was not always meaningful. Figure 7-1 presents a comparison of the mean RAM dust levels at the upwind and downwind stations. If the downwind dust level is higher than the upwind dust level, the bar is positive. If the upwind dust level is higher than the downwind dust level, the bar is negative. Note that the scales in each figure are different. As seen, for the playing and raking scenarios, there does not appear to be a consistent pattern, with upwind dust levels higher than downwind at nearly half of all locations. For the mowing scenario, there tends to be more locations where the downwind dust level is higher than the upwind, but there are still several instances where this is not the case.

Comparison of Asbestos in Upwind and Downwind Stationary Monitors

Air samples at stationary stations upwind and downwind of the outdoor ABS activity were collected for TEM analysis of asbestos in air. Samples were collected to represent the entire duration of the activity. Figure 7-2 presents a comparison of the LA air concentrations upwind and downwind grouped by ABS scenario. In these figures, the error bars represent the 95% Poisson CI. Pairs that were determined to be statistically different from each other, using the ratio method for statistical comparison of two Poisson rates recommended by Nelson (1982), are circled.

As seen, in most instances (46 out of 51 pairs) the LA air concentrations measured at upwind and downwind locations were not statistically different from each other. When differences were statistically different, the downwind LA air concentration was higher than the upwind concentration in 4 of 5 pairs. This finding is similar to the results based on RAM dust levels, emphasizing that under the ABS sampling conditions, the distinction between upwind and downwind was not generally significant. This finding is not unexpected since ABS sampling generally occurred under low wind conditions.

Comparison of Asbestos in Personal and Stationary Monitors

During each ABS scenario, both personal air monitors and stationary air monitors were utilized. The personal air monitors were worn by the individual performing the activity (the monitor height depended upon the type of activity performed). Figure 7-3 presents a comparison of the LA air concentrations from personal monitors and the "downwind" stationary monitors for each property. In these figures, the error bars represent the 95% Poisson CI. Pairs that were determined to be statistically different from each other, using the ratio method for statistical comparison of two Poisson rates recommended by Nelson (1982), are circled.

While LA concentrations in personal air samples are usually not statistically different from the matched stationary downwind air samples, the personal air sample was higher than the corresponding stationary air sample in 14 of 15 pairs. These results indicate that personal air monitors provide a better estimate of potential exposures to LA from outdoor ABS activities than stationary air monitors, at least for the person performing the soil disturbance activity. This is not unexpected, since the personal air monitor is closer to the source material and is less influenced by meteorological conditions (i.e., wind), and thus has a higher probability of capturing releases from the source material as a result of disturbance activities. However, stationary air monitors in the vicinity of a soil disturbance may be useful for estimating potential exposures of "by-standers".

Comparison of Asbestos as a Function of Sample Height (Adult vs. Child)

For the mowing scenario, samples were collected at two different heights to provide information on potential differences in exposures to adult mowers and child mowers. Personal monitors were worn at a height of 3.5-4.5 feet to assess child exposures and 5-6 feet to assess adult exposures. Figure 7-4 presents a summary of the paired TEM LA air concentrations generated during mowing activities from 16 properties. In this figure, the error bars represent the 95% Poisson CI.

Concentrations between the two monitor heights were evaluated using the method for comparison of two Poisson rates described by Nelson (1982). Pairs that were found to be statistically significant are circled in Figure 7-4. At 12 of 16 locations, concentrations at the adult height were not statistically different from the child height. For the four stations where the concentrations were statistically different, TEM LA air concentrations were higher for the adult height at 3 locations and higher for the child height at 1 location. Based on these results, there do not appear to be systematic differences in air concentrations as a function of personal monitor height.

Correlation of LA in Air to Dust in Air

In general, the amount of LA released to air for a specified source level is expected to be proportional to the amount of dust (airborne soil particles) generated during the ABS scenario. Figure 7-5 presents a comparison of mean RAM dust levels from the downwind stationary monitor to measured personal LA air concentrations for each outdoor ABS scenario, stratified by soil PLM-VE bin. For each data series, a best-fit line is shown.

As seen, there does not appear to be a relationship between RAM dust levels and LA air concentrations for any scenario. The reason for this lack of correlation may be due to several factors. However, it is likely that the primary reason is that the RAM dust levels are representative of the downwind stationary monitor and the LA air concentrations are personal monitors. As noted previously, personal monitors provide a better estimate of exposure than stationary monitors. Had the RAM been representative of a personal monitor, a correlation may have become more apparent.

Correlation of LA in Air to LA in Soil

For each outdoor ABS scenario, soil disturbance activities were performed at locations representative of varying LA levels in soil. These locations were initially selected based on PLM soil results generated as part of the Contaminant Screening Study (CSS) and Phase 1 investigations. Locations were selected to be representative of clean fill from remediated areas, and Bin A, Bin B1, Bin B2, and Bin C from unremediated areas. As part of ABS activities, additional soil samples were collected which were representative of the location where the SQAPP outdoor ABS was performed.

Figure 7-6 summarizes the measured LA concentrations for personal air samples stratified by soil level for each outdoor ABS scenario. Figure 7-7 (upper panel) combines data across scenarios. Figure 7-7 (lower panel) presents summary statistics for the combined data set in a "box and whisker" format. In the box and whisker plot, because there are only two results from Bin C soils, results for Bin B2 and Bin C were combined.

As seen, there tends to be wide variability in LA concentrations in outdoor ABS air within each soil classification. The reason for this variability is likely due to numerous factors, including differences in the disturbance intensity as well as differences in soil conditions and meteorological factors. However, inspection of the mean LA air concentrations (Figure 7-7 lower panel) suggests that LA concentrations in air generally tend to increase with increasing soil LA levels. These results also indicate that soil removal activities are effective in reducing exposures from soil disturbances, since ABS scenarios performed on remediated soils yield LA air concentrations that are lower than unremediated soils (even unremediated soils that are non-detect by PLM-VE).

7.2.3 Results for Worker Scenarios

Table 7-3 summarizes the personal air and soil results golf course worker scenario that were collected under SQAPP Task 3C. Personal air samples were collected during mowing and aeration activities, as well as other types of golf course maintenance activities (e.g., raking bunkers). As seen, personal LA air concentrations ranged from non-detect to 0.0029 s/cc, with a mean of 0.0012 s/cc. Both of the stationary monitor air samples were non-detect.

Because the personal air samples collected for golf course workers represent a composite exposure from multiple locations on the golf course, it is difficult to evaluate the relationship between personal air concentrations and LA levels in soil or sand. Soil samples collected from the golf course are presented in Appendix 7.2 and are summarized below:

<table>
<tr><th rowspan="3">Location</th><th colspan="5">Number of Soil Samples</th></tr>
<tr><th rowspan="2">Total</th><th colspan="4">PLM-VE Result</th></tr>
<tr><th>Bin A</th><th>Bin B1</th><th>Bin B2</th><th>Bin C</th></tr>
<tr><td>Tees</td><td>38</td><td>17</td><td>19</td><td>2</td><td></td></tr>
<tr><td>Fairways</td><td>27</td><td>27</td><td></td><td></td><td></td></tr>
<tr><td>Greens</td><td>10</td><td>1</td><td>9</td><td></td><td></td></tr>
</table>

As seen, LA levels in most of the soil samples from the golf course were either non-detect (Bin A) or trace (Bin B1). Average LA concentrations in worker air monitors associated with mowing and aeration activities were lower than mean values associated with ABS scenarios at most Bin A and Bin B1 properties (see Figure 7-7, above). The reason for this difference is not known, but might be related to the fact that the vegetative cover at a golf course will generally be thicker than at most residential properties.

7.3 Conclusions

Because LA levels in soil are reported semi-quantitatively, it is not possible to calculate Ksa for various ABS scenarios as originally envisioned. However, a comparison of LA levels measured in personal air monitors during disturbances at locations stratified according to the semi-quantitative level in soil suggests that exposures generally tend to increase with increasing LA levels in soil. For any specified level in soil, values in air are highly variable, reflecting the complexity of the relationship between soil and air.

8 Task 4: Detection Limits for Soil Methods

EPA has been working to develop and optimize methods for the analysis of low levels (< 1%) of asbestos in soil. To date, EPA's focus has been on developing soil analysis using the PLM-VE method, as well as TEM and possibly SEM. One important attribute of the PLM-VE method and any other method that might be developed is the method detection limit, which is defined for the Libby site as the concentration in soil that yields a result that is recognizably different than clean (reference) soil in a high fraction (e.g., 90%) of all samples.

Based on available results to date, it appears that the PLM-VE method can reliably detect the occurrence of asbestos in soil at a concentration of about 0.2%, but the detection frequency below this value is not well-defined. In order to improve the characterization of the ability of each method to detect asbestos, its is necessary to evaluate the detection limit by analyzing a series of "ultra-low" Performance Evaluation (PE) soil samples that have added LA concentrations in the range of 0.001%-0.2% by mass. Repeated analysis of these samples by PLM-VE and possibly other methods will provide an improved understanding of how detection frequency depends on the true level of LA in the sample. It was originally planned that this work would be performed under Task 4 of the SQAPP. However, responsibility for planning and performing this work has been shifted to the Libby Action Plan (EPA 2007b). Thus, no results for this task are presented in this document.

9 Task 5: Concentration in Soil that is ND by PLM-VE

At present, the primary method for evaluating soil in Libby is PLM-VE. Because many samples are reported as Bin A (non-detect, ND) by this method, it is important to characterize the concentrations of asbestos that may be present in such samples. At present, soil that is ND by PLM-VE is not remediated. Understanding what concentrations may remain after cleanup will help to estimate any future residual risk and help assess the efficacy of the soil cleanup program.

SQAPP Task 5 was designed to investigate the levels of LA in soil samples ranked as ND by PLM-VE, based on re-analysis of these soil samples using TEM and SEM analysis. This section presents the findings of this investigation.

9.1 Study Design

9.1.1 Number of Samples

Because the concentration of asbestos is expected to vary between different soil samples, it is important that a number of samples be collected to characterize the distribution of values which occur. Because the true average and standard deviation for soils that are ND by PLM-VE are not known, it is not possible to perform any *a priori* power calculations to suggest the needed sample size. In the absence of data, the initial sample size was set to 20.

9.1.2 Sample Characteristics

The only required characteristic of the soils for this task is that each has been evaluated previously by PLM-VE and that the result was ND. However, in order to ensure that the soils evaluated are representative, the samples were chosen so that the source locations provide a good spatial coverage of the Libby site. In order to achieve this goal, the community of Libby was divided into a series of zones as follows:

- Zone 1: downtown, east of California Avenue (including Stimson Lumber)
- Zone 2: downtown, west of California Avenue (including the Export Plant)
- Zone 3: the area south of Stimson Lumber
- Zone 4: the vermiculite mine and Rainy Creek Road
- Zone 5: the screening plant and adjacent area known as the flyway
- Zone 6: the area south of the flyway

Several soil samples that were ND by PLM-VE were selected at random from within each zone. In addition, targeted samples from several locations were also included, including samples from near the export plant, from Stimson Lumber, and downwind from the mine. These targeted samples were selected because it is suspected that these locations have a greater probability of having been impacted by releases than other locations not as close to known sources. A total of 20 samples were identified for re-analysis.

9.1.3 Analytical Methods

EPA Region 8 has been working to develop and test several methods for quantifying low levels of asbestos in soil, but to date no one method has proved to yield results of adequate sensitivity, accuracy and precision to meet the requirements of this task. Thus, preliminary measurements were obtained using TEM analysis in accord with SOP EPA-LIBBY-03 and SEM in accord with a method developed by USGS. The mass of each fiber observed is estimated from the dimensions of the fiber and the density, and results are expressed in terms of mass fraction (grams of asbestos per gram of soil).

9.2 Results

Table 9-1 summarizes the PLM-VE, SEM, and TEM results for each soil sample. As seen, with the exception of one sample (1-02175), the reported area fraction (%) by SEM and TEM was below 0.3% for all samples. For sample 1-02175, although the PLM-VE result is reported as non-detect, a prior analysis by NIOSH 9002 reported that LA was present with an area fraction less than 1%. SEM and TEM results for this sample range from 0.93% to 1.74%. The reason that this sample was ranked as ND (Bin A) by PLM-VE is unknown, but might be due to heterogeneity of the soil. If the results from sample 1-02175 are excluded, the mean LA area fraction by both SEM and TEM across all selected samples was about 0.04-0.05%.

Figure 9-1 presents a comparison of the SEM results to the TEM results for each soil sample. As seen, there is relatively high variability between the two methods. The reasons are not certain, but one likely factor is simple statistical variation both in the number of fibers observed and their size.

9.3 Conclusions

The SEM and TEM results from this pilot-scale study demonstrate that the mean concentration of LA is soil samples ranked as non-detect by PLM-VE is likely to be about 0.05% by mass. Because neither TEM nor SEM yield highly stable or consistent results in this low concentration range, the actual average concentration might be either higher or lower.

10 Task 6-9: Time Trends in Asbestos Levels in Air and Dust in Remediated Buildings

Since 1999, EPA has been investigating levels of LA contamination in Libby and has been taking action to remove primary indoor and outdoor sources when encountered. Data on LA levels in air and dust in homes that have undergone indoor cleanup indicate that levels of total LA in air are usually less than about 0.0002-0.0003 s/cc, and levels in dust are usually below about 300-400 s/cm^2 (Volpe & CDM 2004). However, most of these data were collected within a relatively short time period of the cleanup activity. One of the most important issues facing EPA is whether cleanup actions taken in a home result in a long-term reduction in exposure, or whether there is a threat of re-contamination of indoor dust and air from residual sources such as contaminated heating ducts, carpet, vermiculite within walls, etc.

The purpose of SQAPP Tasks 6-9 was to collect data at several different locations in Libby to evaluate whether any time trend indicative of recontamination could be detected. The following scenarios were identified:

> Task 6. Investigate the potential that vermiculite-containing attic insulation (VAI) that is contained within an intact structure (e.g., a wall) is serving as an on-going source of release to indoor dust or air.
>
> Task 7. Investigate whether dust that contains residual LA (at least 500 s/cm^2) but has been left in place is serving as an important source of asbestos in indoor air.
>
> Task 8. Investigate whether homes where residents are actively using HEPA vacuums for routine cleaning are tending to have decreased asbestos concentrations in dust over time.
>
> Task 9. Investigate if carpets are serving as an important residual source, either due to asbestos within the carpet or beneath the carpet.

This section summarizes these sampling and analysis efforts, and presents the findings of the investigation.

10.1 Study Design

Sampling Locations

A total of four homes in Libby were selected in accordance with the selection criteria specified in the SQAPP, as modified in Libby Field Modification (LFO) #86 and #96 (see Appendix 10.1). These homes were selected to monitor indoor air and indoor dust for a period of up to 16 months following indoor cleanup. Table 10-1 shows which of these sources are applicable in each of the four properties selected for monitoring. In accord with recommendations which EPA has made to the community, all four of these properties had been provided with a HEPA vacuum and the residents reported that they used the HEPA vacuum on a regular basis.

Sample Collection and Analysis

At each location selected for post-cleanup time trend monitoring, samples of indoor dust and indoor air (both from stationary samplers and personal air monitors worn by residents) were collected at time intervals of about 3 months, 12 months, and 16 months post-cleanup[d].

All stationary air and dust sampling locations represented living areas frequently used by the residents, and the sampling locations were the same for each of the three sequential sampling events. All residents who agreed to wear personal air monitors during the sampling event were provided instructions on what to do when leaving the house, and were provided an activity log to record what general types of activities were engaged in when in the home.

All air samples (both personal and stationary) were collected under routine living conditions. The flow rates were approximately 8-10 L/min and the collection time was between 8-10 hours. Stationary air samples were collected at the adult breathing zone height (about 5 feet). For the three homes where carpets were evaluated as a potential source, stationary samples were also placed at a height equivalent to a child sitting on the floor (about 2 feet)[e]. Air samples were analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for stationary air analysis was 0.00004 cc^{-1}.

Because the indoor samples collected immediately after the clean-up at each property (these are referred to as "clearance" samples) were only analyzed to an analytical sensitivity of 0.005 cc^{-1}, all of the clearance samples from these 4 homes were reanalyzed to achieve a target sensitivity around 0.00004 cc^{-1}.

All dust samples were composites from 3 different locations in the main living area of the house (total sample area = 300 cm^2) collected using the standard microvacuum method based on ASTM D5755-95 established for use at the site. Dust samples were analyzed by TEM using ASTM counting rules. The target sensitivity for dust analysis was 20 cm^{-2}.

10.2 Results

Tables 10-2 and 10-3 provide the detailed sample results at each time interval for each of the four properties for air and dust, respectively. For dust, because collection of "clearance" dusts is not performed, dust samples collected prior to the cleanup are used to indicate the likely levels at the time of clearance.

[d] Sample timing is different from time intervals specified in the SQAPP (3 months, 9 months, 18 months) due to a miscommunication in the field.

[e] Child height stationary monitors were evaluated as part of the 12-month and 16-month post-clearance sampling events.

Evaluation of Time Trends

Figures 10-1 and 10-2 present the measured data for each property at each time interval for air and dust, respectively. In these figures, the error bars represent the 95% Poisson CI around each individual sample. As seen, LA concentrations in air samples collected 3 months and 12 months post-clearance tended to be similar to concentrations measured in the clearance samples collected immediately following cleanup activities. However, LA concentrations appear to have increased at two properties for samples collected 16 months post-clearance. The reason for this increase is not known, but does not appear to be related to an increase in indoor dust levels (see Figure 10-2). As seen in Figure 10-2, dust levels remain low across all post-clearance time intervals at all properties.

Table 10-4 presents detailed property-specific information on the types of heating systems in use, a characterization of interior and exterior contamination (past and current), and a summary of any removal efforts that were completed. As seen, the only similarity between the two properties with increased air concentrations is that they each had an exterior soil removal performed. However, this data set is much too small to determine which of these factors, if any, is associated with the tendency for indoor air levels of LA to increase after time.

Comparison of Adult Height vs. Child Height

Figure 10-4 compares the concentration values for LA in air measured at the adult and child height. As seen, the values tended to fall along the line of identity, suggesting that there was little difference as a function of height. This was further evaluated by using the method for comparison of two Poisson rates described by Nelson (1982). At all locations, concentrations at the adult height were not statistically different from the child height. Based on these results, there do not appear to be systematic differences in air concentrations as a function of personal monitor height.

10.3 Conclusions

Data on LA concentrations in four homes studied over a period of 16 months indicate that, for 12 months, no upward time trends were apparent, but that an increase did occur at 16 months in two homes. The reason for this apparent rebound is not known. A review of property characteristics (i.e., heating methods, types of interior/exterior cleanup activities performed, asbestos sources remaining) does not provide any clear hypothesis regarding which residual source might be responsible. However, the apparent increase in indoor air levels was not accompanied by an increase in the indoor dust level.

11 Task 10: Dust Concentrations Under Carpets

Under the current cleanup protocol (EPA 2003), dust under carpets is not investigated and not remediated. To date, EPA has been able to achieve indoor air clearance standards leaving carpets in place, and post-cleanup sampling suggests that carpets left in place have not significantly re-contaminated living spaces after some time has passed. Thus, asbestos within carpets does not appear to be a major source of concern. However, if a carpet that is contaminated with asbestos is removed, fibers that have accumulated under the carpet could be released to air, potentially causing short-term inhalation exposures of residents or carpet workers, and also potentially causing re-contamination of the home.

In order to investigate whether or not this exposure scenario is likely to be of concern, Task 10 of the SQAPP collected samples from dust under carpets at a number of homes in Libby and analyzed these samples for LA. This section summarizes this sampling and analysis effort, and presents the findings of the investigation.

11.1 Study Design

Sampling Locations

Details of the study design for Task 10 are provided in the SQAPP (EPA 2005). In brief, it was considered likely that the amount of LA that might occur under a carpet would depend on the age of the carpet and the number of different transport pathways by which LA might be brought into the indoor environment. Pathways that were considered in this effort included occupancy of the home by a former mine worker, presence of indoor vermiculite insulation, and presence of visible vermiculite and/or LA in outdoor soil (as identified by PLM). Therefore, the sampling plan called for the collection of samples from a number of different locations, stratified according to carpet age and the presence or absence of transport pathways, as follows:

Age of Carpet	Number of Transport Pathways Identified	
	None	One or More
5-10 years	2	2
10-20 years	2	2
> 20 years	2	2

Information on carpet age and the number of potential transport pathways was derived from interviews with the current residents. Properties with carpets that had been regularly vacuumed with a HEPA vacuum were excluded, since HEPA vacuuming would likely result in lower LA levels in dust that would occur in the absence of HEPA vacuuming. Two properties for each of the combinations of carpet age and transport pathway status selected, yielding a total of 12 dust sampling locations. None of these properties had undergone indoor dust cleanups by EPA at the time of sampling.

Sample Collection and Analysis

All dust samples from under the carpet were collected using the standard microvacuum technique based on ASTM D5755-95 established for use at the site. The area vacuumed consisted of 2-6 templates (each 100 cm^2), with the number of areas vacuumed dependent on the amount of dust present beneath the carpet (more templates for low dust loading). In all cases, dust samples were collected from high-traffic areas. Carpets were replaced after sampling was completed.

Dust samples from beneath carpets were analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for dust analysis was 200 cm^{-2}.

11.2 Results

Table 11-1 provides the detailed results for dust field samples collected under Task 10. As seen, 8 of the 12 samples did not contain detectable levels of LA at an analytical level of about 200 cm^{-2}. Four of the samples did contain detectable levels of LA, with observed LA loadings ranging from 180 to 1,600 s/cm^2. These all occurred in carpets that were older than 10 years. The highest level was detected at the only property where occupancy by a former miner was noted.

11.3 Conclusions

While the small amount of data collected from this pilot-scale investigation of dust under carpets is too limited to draw firm conclusions, these results indicate that LA may occur in dust under some carpets, with an apparent tendency for levels to be higher for older carpets. Additional sampling would be needed to assess the level of exposure that may occur during carpet removal activities.

12Task 11: Safety Factor

All homes that undergo indoor cleanup to remove a potential source such as unenclosed vermiculite or contaminated dust are subject to a clearance test of indoor air after cleanup activities have been completed before residents may re-occupy the property. The clearance test consists of using a leaf-blower to vigorously disturb any dust that remains in the house, and then collecting stationary air samples immediately following the disturbance. A property is declared to be suitable for re-occupation only if 5 of 5 samples are non-detect by the TEM-AHERA counting method, with each clearance sample analyzed to a target analytical sensitivity of 0.005 $(cc)^{-1}$. This ensures that there is a high probability that the LA concentrations in air after cleanup activities are less than 0.001 s/cc.

Because the clearance samples are collected immediately following an active disturbance with a leaf-blower, it is considered likely that the levels in air existing under conditions of routine household activities will be lower than following the leaf-blower disturbance. That is, the difference in airborne concentration of asbestos between an active leaf-blower scenario (< 0.001 s/cc) and a routine activity scenario is thought to provide a certain margin of safety in decision-making. However, the magnitude of the difference between a clearance sample collected after leaf-blower disturbance and a routine sample collected without leaf-blower disturbance has not been measured.

The purpose of SQAPP Task 11 was to collect air samples from remediated properties in order to characterize the level of LA in indoor air under routine conditions several days after completion of indoor cleanup and collection of clearance samples. This section summarizes this sampling and analysis effort, and presents the findings of the investigation.

12.1 Study Design

Details of the study design for Task 11 are provided in the SQAPP (EPA 2005). In brief, a total of nine homes in Libby were selected at random from the group of homes that were undergoing interior cleanup and air clearance sampling. Table 12-1 presents a summary of the selected properties and provides a description of the types of interior cleanup activities conducted at each property.

Stationary Air Samples

At each property, a routine stationary air sample was collected in the main living area 2-3 days after the collection of the original clearance samples. It was assumed that this time period would allow dust disturbed by the leaf-blower during clearance sampling activities to re-settle. These stationary air samples (collected 2-3 days after the original clearance) will be referred to as "post-clearance" samples.

All post-clearance air samples were analyzed for asbestos by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for air analysis was 0.00004 cc^{-1}.

Indoor Dust

Composite dust samples were also collected at each property from approximately three 100-cm^2 template areas located in the main living space of the house using the standard microvacuum method based on ASTM D5755-95 established for use at the site. Samples were collected from both horizontal surfaces and high traffic areas. Table 12-2 identifies the indoor dust samples that were collected as part of SQAPP Task 11. These dusts were not analyzed, but were archived for possible future analysis, depending upon the results of the stationary air samples.

12.2 Results

Appendix 12.1 provides the detailed results for the clearance samples collected at each property immediately following cleanup actions after disturbance with a leaf-blower. No LA structures were observed in any clearance sample and the pooled total LA air concentration was less than 0.001 s/cc for all properties. Because the post-clearance samples were all collected from living areas and not attics, for the purposes of comparing clearance samples with post-clearance, only those clearance samples collected from living areas were included in this evaluation.

Table 12-3 provides the detailed results for all post-clearance air samples collected under Task 11 of the SQAPP. As seen, with the exception of one sample (SQ-00157), all samples achieved a target analytical sensitivity of 0.00006 $(cc)^{-1}$, which is about 15 times lower than the pooled analytical sensitivity achieved for the clearance samples (0.001 cc^{-1}). Sample SQ-00157 was prepared for analysis using an indirect preparation because of debris overloading on the primary filter. The sensitivity achieved for this sample was about 0.0004 $(cc)^{-1}$. The detection frequency of LA in the post-clearance samples was 8/9, with concentrations of total LA ranging from non-detect to 0.00078 s/cc (mean = 0.00034 s/cc).

Because the clearance samples were not reanalyzed to a low analytical sensitivity, it is not possible to compute a meaningful estimate of the mean concentration and to perform a quantitative comparison of the clearance and post-clearance samples. However, the mean value for post-clearance (0.00034 s/cc) is about 3-times lower than the limit established by the clearance samples (< 0.001 s/cc).

12.3 Conclusions

The data presented support the conclusion that the concentration of LA in post-clearance indoor air samples collected within 2-3 days of interior cleanup activities average about 0.0003 s/cc, which is about 3-times lower than the limit of 0.001 s/cc established during clearance sampling.

13Task 12A: Re-Analysis of Ambient Air Samples

13.1 Summary of Early Outdoor Ambient Air Monitoring in Libby

Beginning around 2000, EPA began collecting outdoor ambient air samples at a number of locations around the community in order to gain an initial understanding of the levels of LA typically observed in outdoor air. Locations where samples were collected included:

- Fitness Center at the City Hall Building (952 East Spruce Street)
- McGrade Elementary School (899 Farm to Market Road)
- Plummer Elementary School (247 Indian Head Road)
- Rainy Creek Road
- Lincoln County Courthouse Annex (418 Mineral Avenue)
- Lincoln County Landfill
- Station FA-1 (on the northwestern boundary of the "River Runs Through It" subdivision)
- Stimson Lumber Property

In addition, samples of outdoor ambient air were collected at 27 properties in Libby where EPA clean-up activities were scheduled. These samples were collected before clean-up began, and the measurements were intended to help determine if the cleanup activities caused a measurable release to outdoor ambient air.

13.2 Ambient Air Sample Identification

For the purposes of this report, an outdoor ambient air sample is defined as any stationary outdoor air sample collected in or about the community under conditions where there were no known nearby activities or disturbances that might cause a temporary elevation of LA fibers in air. All outdoor ambient air samples were collected using stationary air monitors. This type of sampler draws a known volume of air (typically 1000-4000 L) through a mixed cellulose acetate filter, trapping asbestos particles on the filter surface.

Appendix 13.1 provides detailed information on how the ambient air samples were identified in the Libby 2DB. After implementing the selection criteria, a total of 404 ambient air samples were identified. These ambient air samples were analyzed for asbestos primarily by TEM using either ISO 10312 or AHERA counting rules. If a sample was analyzed more than once by TEM, results were pooled as specified in Appendix 3.1. Appendix 13.2 presents the detailed TEM results for these 404 ambient air samples.

For convenience, these samples are grouped according into several spatial zones, as follows:

- Zone 1: downtown, east of California Avenue
- Zone 2: downtown, west of California Avenue
- Zone 3: the area south of Stimson Lumber
- Zone 4: the vermiculite mine and Rainy Creek Road
- Zone 5: the screening plant and adjacent area known as the Flyway

Figure 13-1 shows the general locations of the ambient air samples, along with a brief description of each site and a summary of the number and dates of samples collected.

Table 13-1 presents summary statistics for the 404 outdoor ambient air samples, stratified by zone. As shown, the two highest detection frequencies (17%-34%) and the two highest mean air concentrations of LA (approximately 0.0005 to 0.002 s/cc) were observed in Zone 4 (Rainy Creek Road and the mine area) and in Zone 5 (the screening plant area). In the main commercial and residential sections of Libby (Zones 1, 2 and 3), the detection frequency was lower [(12+2+2)/261 = 6%] than in Zones 4 and 5, and the mean concentration of LA in Zones 1, 2 and 3 also tended to be lower (approximately 0.0001 to 0.0002 s/cc) than the mean concentrations in Zone 4 or 5.

Within the main commercial and residential sections of Libby (Zones 1, 2, and 3), Zone 1 exhibited a higher detection frequency (11%) compared to Zone 2 (2%) or Zone 3 (4%). Overall (all five zones combined), 60 of 404 ambient air samples (15%) were observed to contain one or more LA structures. The average concentration across all 404 ambient air samples is 0.00068 s/cc. However, confidence in this estimate of the mean concentration of LA in outdoor ambient air in Libby is limited by the high frequency of non-detects, and by the relatively high sensitivity (0.003 cc^{-1}).

In considering these results, it is important to note a number of potential limitations to the data (EPA 2006). These data lack seasonal and geographical representation over time, and there are a number of samples with inadequate sensitivities. For these reasons, these preliminary data are not considered adequate for supporting conclusions about long-term average LA levels in outdoor ambient air in Libby.

13.3 Need for Re-Analysis of Ambient Air Samples

As noted above, one of the limitations in the data set of outdoor ambient air samples was a relatively poor analytical sensitivity (about 0.003 cc^{-1}) in many samples. Therefore, in order to help evaluate this limitation, EPA determined that a supplemental analysis of a selected set of samples would be helpful in providing a clearer picture of LA levels in outdoor ambient air.

Sample Selection

A total of 33 samples were selected for re-analysis from the set of 404 outdoor ambient air samples. These 33 samples were selected using a stratified random approach in which a number of samples were selected for each zone and each year. In selecting samples for re-analysis, greatest emphasis was placed on Zones 1, 2 and 3, since these zones represent the main residential and commercial areas of Libby. Only one residential property is represented in the outdoor ambient air dataset within Zone 5 and no residential properties are represented in Zone 4. Therefore, no samples were selected for re-analysis from Zone 4 and one sample was selected from the single residential property in Zone 5.

Sample Analysis

Each sample was re-analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for air analysis was 0.0001 $(cc)^{-1}$, about 20- to 50-fold lower than the original analysis.

13.4 Results After the Re-analysis

Comparison of Original Results to Re-Analysis Results

Appendix 13.3 provides the detailed analytical results for the 33 outdoor ambient air samples selected for re-analysis. Table 13-2 presents summary statistics for the original results for these 33 samples (Panel A), and the results following re-analysis (Panel B).

As seen, the re-analysis resulted in an average sensitivity that was about 25 times lower than the original sensitivity (decreasing from 0.0025 cc^{-1} to 0.0001 cc^{-1}), and the best estimate of the mean decreased from 0.00055 s/cc to 0.00021 s/cc. A more detailed pair-wise comparison of the original and re-analysis results of the 33 selected samples is presented in Figure 13-2. The error bars in this figure represent the 95% Poisson CI around each measured concentration. As shown, the primary effect of re-analysis is to substantially decrease the uncertainty bounds around each estimate, while simultaneously improving the best estimate of the mean outdoor ambient air concentration.

Time Trends

Figures 13-3 and 13-4 show the measured concentration of LA in each sample stratified by zone and by collection date, for all 404 ambient air samples and the 33 re-analysis samples, respectively. The error bars in these figures indicate the 95% Poisson CI around each measured value. Inspection of these figures reveals that there is little or no apparent time trend in outdoor ambient air samples over the period of 2000-2002. However, this may be because the time interval over which samples were collected is too narrow to detect the beneficial effects of remedial activities in the community.

13.5 Conclusions

These results indicate that LA occurs in outdoor ambient air in Libby. Based on the original and the re-analyzed data, concentration levels do not appear to be substantially different at different locations within the main residential-commercial section of Libby (Zones 1-3), but may be somewhat higher closer to the mine (Zones 4 and 5). However, in considering these results, it is important to recognize that these samples were not collected in a way that ensures the samples are representative over space or time, so the results should be viewed as preliminary (EPA 2006). It is for this reason that EPA is currently collecting additional outdoor ambient air data to provide a much clearer characterization of levels, spatial patterns, and time trends.

14 Task 12B: Re-Analysis of Perimeter Air Samples

14.1 Summary of Perimeter Air Monitoring in Libby

In performing soil cleanup activities, EPA employs a range of engineering strategies to minimize releases of asbestos into air that might otherwise result from soil disturbances. During soil cleanup activities, EPA collects samples of outdoor air from one or more stationary monitors near the cleanup activities in order to evaluate the effectiveness of the controls. These samples are typically referred to as "perimeter" air samples.

14.2 Perimeter Air Sample Identification

At the time of the SQAPP, soil cleanups had been performed at more than 350 locations in Libby. Appendix 14.1 provides detailed information on how the perimeter air samples were identified in the Libby 2DB. After implementing the selection criteria, a total of 8,510 perimeter air samples were identified. These perimeter air samples were collected using stationary air monitors and were analyzed for asbestos primarily by TEM using either ISO 10312 or AHERA counting rules. If a sample was analyzed more than once by TEM, results were pooled as specified in Appendix 3.1. Appendix 14.2 presents the detailed TEM results for these 8,510 perimeter air samples.

Table 14-1 lists locations in Libby where EPA has collected perimeter air samples in association with soil cleanup activities, and indicates the number of samples collected, provides the sampling date range, and summary statistics for perimeter air samples at each location. Table 14-2 provides a summary of perimeter air concentrations across all locations stratified by year. As seen, mean LA air concentrations and sample detection frequencies tended to be higher for 2000-2002 compared to 2003-2005. This is primarily because soil cleanups performed prior to 2003 included locations that were associated with the mine, or had the highest levels of soil contamination and were more extensive in size, while more recent soil cleanups have tended to occur mainly in residential locations. Based on the dataset across all years, 85% of all samples were non-detects. This low detection frequency suggests that engineering controls are effective in limiting releases of LA to outdoor air during EPA soil cleanup activities, but this conclusion is limited by the relatively high analytical sensitivity for most perimeter air samples (mean = 0.004 cc^{-1}, range = 0.0004 to 0.12 cc^{-1}).

14.3 Need For Re-Analysis of Perimeter Air Samples

As noted above, about 85% of the existing perimeter air samples were non-detect. While these results are consistent with the conclusion that engineering controls used for dust suppression are effective in limiting asbestos releases to air at outdoor cleanup projects in Libby, the data are limited by the relatively large fraction of all perimeter samples that are non-detects and with high (poor) analytical sensitivities. Therefore, SQAPP Task 12B called for the re-analysis of a selected subset of the existing perimeter air samples to achieve a lower detection limit and thus, an improved understanding of the actual air concentrations of asbestos during site clean-up activities.

Sample Selection

Locations where perimeter samples had been collected were stratified according to the extent of soil removal [small (< 1,000 cubic yards) or large (≥ 1,000 cubic yards)] and the concentration of LA asbestos in the soil [low = < 1% (PLM-VE Bins A, B1 or B2) or high = ≥ 1% (PLM-VE Bin C)]. Specific locations selected for analysis included residential properties for the small sites, and locations such as the export plant and the flyway for the large sites. Other locations were selected for each category at random. Selected locations were grouped into four categories based on the soil cleanup attributes, as follows:

Group A: "Low" LA Soil Level (< 1%), "Small" Removal Size (< 1000 cy)
Group B: "High" LA Soil Level (≥ 1%), "Small" Removal Size (< 1000 cy)
Group C: "Low" LA Soil Level (< 1%), "Large" Removal Size (≥ 1000 cy)
Group D: "High" LA Soil Level (≥ 1%), "Large" Removal Size (≥ 1000 cy)

In order to seek a representative set of samples for re-analysis, 4-6 locations for each group were identified, for a total of 20 locations. Table 14-3 summarizes the 20 locations selected for re-analysis of perimeter samples. Figure 14-1 shows the location of the 20 properties selected for each group. A total of 1,221 perimeter air samples were collected at these 20 properties.

Appendix 14.3 presents the original TEM results for these 1,221 perimeter air samples. Table 14-4 summarizes the results by property and by group. As seen, 1,134 of 1,221 samples (93%) were non-detect. The detection frequency of LA in air for properties in Group D (10%) tended to be higher than for properties in Groups A, B, or C (1-2%). The mean sensitivity for these samples was 0.0037 cc^{-1}, which limits the ability to derive accurate estimates of the true concentration of LA in the samples. Therefore, a subset of 20 samples, including both detects and non-detects, were selected at random for re-analysis from this list of 1,221 perimeter air samples. Table 14-5 provides a list of the 20 perimeter air samples selected for re-analysis.

Re-Analysis methods

Each sample was re-analyzed by TEM using the modified ISO 10312 counting rules, as specified in the SQAPP. The target sensitivity for air analysis was 0.001 cc^{-1}, about 4 times lower than the original analysis.

14.4 Results

14.4.1 Comparison of Original Results to Re-Analysis Results

Appendix 14.4 provides the detailed analytical results for the 20 perimeter air samples selected for re-analysis. Table 14-6 presents summary statistics for the original results for these 20 samples (Panel A), and the results following re-analysis (Panel B). As seen, the re-analysis resulted in an average sensitivity that was about 5 times lower than the original sensitivity (decreasing from 0.0037 cc^{-1} to 0.00081 cc^{-1}). As a consequence, the detection frequency increased from 6/20 to 10/20, but the mean air concentration decreased from 0.0014 s/cc to 0.00051 s/cc.

A more detailed pair-wise comparison of the original and re-analysis results of the 20 selected samples is presented in Figure 14-2. The error bars in this figure represent the 95% Poisson CI around each measured concentration. For the original results, the confidence interval bounds are often quite wide. A comparison of the width of the confidence interval bounds between the original result and the re-analysis result demonstrates how the uncertainty due to measurement error has decreased after the re-analysis due to improved analytical sensitivity. Thus, the re-analysis provides a better estimate of the true LA concentration in air for these perimeter samples, and indicates that results based on the original analyses (with high sensitivity) may to tend to overestimate the true concentration.

14.4.2 Comparison of Perimeter Air to Ambient Air

As described in previously in Section 13, data are available on the level of LA in outdoor ambient air in Libby. A comparison of perimeter air concentrations to outdoor ambient air concentrations was performed based on the subset of ambient and perimeter samples that were re-analyzed to a lower (better) sensitivity. These datasets were used for the comparison because, if there are differences between perimeter air and outdoor ambient air, these data are more likely to detect the difference because of the improved sensitivity.

Table 14-7 presents the comparison of perimeter air concentrations to outdoor ambient air concentrations. As seen, the mean air concentration for the 20 low sensitivity perimeter air samples (0.00051 s/cc) is about 2 times higher than the mean air concentration for the low sensitivity ambient air samples from Libby (0.00021 s/cc). If this comparison is restricted to locations which are generally representative of residential cleanups (Group A and Group B), mean perimeter air concentration is about 1.5 times higher than the mean outdoor ambient air concentration.

This comparison suggests that measured LA levels in air at properties where soil cleanup activities are actively occurring are slightly higher than LA levels in outdoor ambient air at Libby in the absence of cleanup actions. However, it is important to understand that, while potential releases of LA into air may occur due to soil cleanup activities, this does not necessarily mean that these levels are in a range of potential health concern.

14.5 Conclusions

Perimeter air monitoring data show that releases of LA to air during EPA soil cleanup activities are typically low, and that the engineering controls that are used to limit emissions are generally successful. Concentrations of LA in perimeter air samples tended to be higher for samples collected prior to 2003, when soil remediation efforts occurred mainly in locations that were associated with the mine and/or had the highest levels of soil contamination, compared to samples collected more recently (2003 to 2005), when soil remediation efforts occurred mainly in residential locations. In general, measured air concentrations of LA in perimeter air monitoring samples were about 1.5 to 2 times higher than measured levels of LA in outdoor ambient air at Libby.

15References

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	Insect Tissue EPC
Aluminum	295.7
Antimony	NC
Arsenic	NC
Barium	18.45
Beryllium	NC
Cadmium	2.281
Calcium	1709
Chromium	1.034
Cobalt	1.525
Copper	124.8
Iron	369.2
Lead	71.94
Magnesium	1389
Manganese	191.5
Mercury	NC
Nickel	NC
Potassium	7777
Selenium	NC
Silver	3.075
Sodium	1130
Thallium	NC
Vanadium	0.998
Zinc	205.9

TABLES

Table 2-1. Summary of SQAPP Analysis Verification

Panel A: TEM Analyses

SQAPP Task	N Analyses Performed	N Analyses Selected for Verification	N Analyses Verified (a)	% Verified
2	166	155	133	80%
3	197	20	20	10%
6-9	44	44	44	100%
10	13	4	4	31%
11	9	5	5	56%
12 (ambient)	37	37	36	97%
12 (perimeter)	26	26	24	92%
ALL	492	291	266	54%

Panel B: PLM Analyses

SQAPP Task	N Analyses Performed	N Analyses Selected for Verification	N Analyses Verified (a)	% Verified
1	37	5	5	14%
3	38	7	8	21%
ALL	75	12	13	17%

(a) Some of the analyses selected for verification could not be verified because the laboratory benchsheets were not available for review.

Table 3-1
Relationship Between Number of Structures Observed and Relative Uncertainty

Number of Structures Observed (N)	2.5% Lower Bound N (LB)	97.5% Upper Bound N (UB)	95% Confidence Interval Range (CI) [UB-LB]	Relative Uncertainty [CI/N]
0	0.00	2.51	2.51	+Infinity
1	0.11	4.67	4.57	457%
2	0.42	6.42	6.00	300%
3	0.84	8.01	7.16	239%
5	1.91	10.96	9.05	181%
10	5.14	17.74	12.60	126%
20	12.61	30.28	17.67	88%
50	37.54	65.35	27.81	56%
75	59.44	93.46	34.02	45%
100	81.82	121.08	39.26	39%

2.5% LB = 0.5 · CHIINV[0.975, (2 · N+1)]
97.5% UB = 0.5 · CHIINV[0.025, (2 · N+1)]

TABLE 4-1
SQAPP Field Duplicate/Replicate Results

PANEL A: SURFACE SOIL

Original Index ID	Duplicate Index ID	SQAPP Task	Sample Date	Sample Depth (inches)	Location Description	PLM-VE Results: Original LA MF (%)	PLM-VE Results: Field Duplicate LA MF (%)	Concordance
SQ-00148	SQ-00149	1	27-Jun-05	0-6	Back, front, side yard	ND	ND	Concordant
SQ-00160	SQ-00241	1	29-Jun-05	0-6	Back, front, side yard	ND	Trace	Weakly Discordant
SQ-00317	SQ-00319	3B_mowing	15-Jul-05	0-2	Front yard	ND	ND	Concordant

PANEL B: STATIONARY AIR

Original Index ID	Duplicate Index ID	SQAPP Task	Sample Date	Sample Location Description	TEM ISO 10312 Results: Original				TEM ISO 10312 Results: Field Replicate				Poisson Rate Comparison (95% CI)
					Prep Method	Sensitivity $(cc)^{-1}$	Count	Conc (s/cc)	Prep Method	Sensitivity $(cc)^{-1}$	Count	Conc (s/cc)	
SQ-00096	SQ-00097	3B_playing	22-Jun-05	Outdoor	Indirect	0.036	1	3.6E-02	Indirect	0.036	1	3.6E-02	Concentrations are not different
SQ-00140	SQ-00181	2	27-Jun-05	Indoor	Direct	0.000059	4	2.4E-04	Direct	0.000061	9	5.5E-04	Concentrations are not different
SQ-00290	SQ-00291	3B_raking	08-Jul-05	Outdoor	*not analyzed*				*not analyzed*				
SQ-00336	SQ-00337	3B_mowing	12-Jul-05	Outdoor	Direct	0.00099	0	0.0E+00	Direct	0.00097	0	0	Concentrations are not different
SQ-00357	SQ-00358	3B_raking	11-Jul-05	Outdoor	Direct	*overloaded (a)*			Direct	*overloaded (a)*			
SQ-00419	SQ-00420	3B_mowing	13-Jul-05	Outdoor	Direct	0.0011	0	0	Direct	0.0011	0	0	Concentrations are not different
SQ-00458	SQ-00459	3B_mowing	16-Jul-05	Outdoor	Direct	0.00098	0	0	Direct	0.0010	0	0	Concentrations are not different
SQ-00475	SQ-00476	3B_mowing	15-Jul-05	Outdoor	Indirect	0.0033	0	0	Indirect	0.0021	5	1.1E-02	Concentrations are not different
SQ-00489	SQ-00490	3B_playing	14-Jul-05	Outdoor	Direct	0.00086	9	7.7E-03	Direct	0.0010	15	1.6E-02	Concentrations are not different
SQ-00592	SQ-00593	3B_mowing	19-Jul-05	Outdoor	Direct	0.00099	0	0	Direct	0.00098	0	0	Concentrations are not different

(a) sample was rejected due to heavy unstable debris

TABLE 4-2
Concordance Results for Recount Analyses of Grid Openings with One or More Asbestos Structures Observed

Analysis Summary									GO-Specific Evaluation			
Recount Type	Index ID	Medium	Prep	Analysis Method	Laboratory		Grid	GO	LA Structure Count			
					Original	Recount			Original	Recount	Difference	Concordant?
Recount Same	SQ-00176	Air	Direct	ISO	Westmont	Westmont	1	M13	1	1	0	Yes
							1	L11	1	1	0	Yes
							2	B7	1	1	0	Yes
							2	G5	1	1	0	Yes
							2	E15	1	1	0	Yes
	SQ-00359	Dust	Indirect	ASTM	RESI	RESI	A	G3-4	0	0	0	Yes
							A	E3-3	0	0	0	Yes
Verified Analysis	SQ-00265	Air	Direct	ISO	Hygeia	Hygeia	C5	F6-1	1	1	0	Yes
	SQ-00482	Air	Direct	ISO	MAS	MAS	B8	G4	1	1	0	Yes
	SQ-00489	Air	Direct	ISO	MAS	MAS	A2	B9	3	3	0	Yes
Interlab	SQ-00208	Air	Indirect	ISO	Hygeia	Batta	A9	H4-3	3	3	0	Yes
							A9	H4-2	4	5	-1	No
							A9	H4-1	2	3	-1	No
							A9	E3-3	4	4	0	Yes
							A9	F3-3	4	2	2	No
							A10	F3-1	1	1	0	Yes
							A10	C4-2	4	4	0	Yes
							A10	F4-1	2	2	0	Yes
							A10	F4-4	3	3	0	Yes
	SQ-00321	Air	Indirect	ISO	Batta	MAS	3	B6	1	0	1	No
							3	E1	2	1	1	No
							3	E8	1	1	0	Yes
							3	G7	2	2	0	Yes
							3	I1	3	5	-2	No
							3	I3	0	1	-1	No
							3	I9	1	1	0	Yes
							3	J8	2	2	0	Yes
							4	A7	1	0	1	No
							4	B10	1	1	0	Yes
							4	C8	1	1	0	Yes
							4	D5	0	1	-1	No
							4	D10	1	1	0	Yes
												23/32 *72%*

TABLE 4-3
Detailed Structure Concordance Results for Recount Analyses with One or More Asbestos Structures Observed

Analysis Summary									Structure-Specific Evaluation												
					Laboratory				Original					Recount					Concordant?		
Recount Type	Index ID	Medium	Prep	Analysis Method	Original	Recount	Grid	GO	Mineral Class	Structure Type	Length (um)	Width (um)	Aspect Ratio	Mineral Class	Structure Type	Length (um)	Width (um)	Aspect Ratio	Mineral Class	Length	Width
Recount Same	SQ-00176	Air	Direct	ISO	Westmont	Westmont	1	M13	LA	F	16.0	0.6	26.7	LA	F	16.0	0.6	26.7	Yes	Yes	Yes
							1	L11	LA	F	11.0	1.3	8.8	LA	F	11.0	1.3	8.8	Yes	Yes	Yes
							2	B7	LA	MF	3.5	0.5	7.0	LA	MF	3.5	0.5	7.0	Yes	Yes	Yes
							2	G5	LA	F	20.0	1.4	14.8	LA	F	20.0	1.4	14.8	Yes	Yes	Yes
							2	E15	LA	MF	11.0	0.5	22.0	LA	MF	11.0	0.5	22.0	Yes	Yes	Yes
	SQ-00359	Dust	Indirect	ASTM	RESI	RESI	A	G3-4	C	F	2.0	0.1	35.0	C	F	2.0	0.1	35.0	Yes	Yes	Yes
							A	E3-3	C	M	4.5	0.1	53.3	C	M	4.5	0.1	53.3	Yes	Yes	Yes
Verified Analysis	SQ-00265	Air	Direct	ISO	Hygeia	Hygeia	C5	F6-1	LA	F	11.8	1.3	9.0	LA	F	12.1	1.3	9.2	Yes	Yes	Yes
	SQ-00482	Air	Direct	ISO	MAS	MAS	B8	G4	LA	MF	8.0	0.2	40.0	LA	MF	2.6	0.1	26.0	Yes	No	Yes
	SQ-00489	Air	Direct	ISO	MAS	MAS	A2	B9	LA	F	7.0	0.2	35.0	LA	F	9.0	0.3	30.0	Yes	No	Yes
									LA	F	9.2	0.2	46.0	LA	F	10.0	0.3	33.3	Yes	Yes	Yes
									LA	MF	9.5	0.2	47.5	LA	MF	10.0	0.2	50.0	Yes	Yes	Yes
Interlab	SQ-00208	Air	Indirect	ISO	Hygeia	Batta	A9	H4-3	LA	F	5.7	0.7	7.9	LA	F	5.6	0.7	8.0	Yes	Yes	Yes
									LA	F	6.1	0.6	10.2	LA	F	6.1	0.6	10.2	Yes	Yes	Yes
									LA	MF	2.8	0.7	3.9	LA	F	2.9	0.7	4.1	Yes	Yes	Yes
							A9	H4-2	C	F	4.9	0.1	50.0	C	F	4.9	0.1	61.3	Yes	Yes	Yes
									LA	F	2.3	0.3	8.8	LA	F	2.3	0.3	7.7	Yes	Yes	Yes
									LA	MF	3.2	0.4	8.2	LA	MD10	3.1	0.4	7.8	Yes	Yes	Yes
									LA	F	2.1	0.2	12.8	LA	MD10	3.1	0.3	10.3	Yes	No	Yes
									LA	MF	4.7	0.4	11.8	no matching structure identified					–	–	–
									no matching structure identified					LA	MD11	1.2	0.3	4.0	–	–	–
									no matching structure identified					LA	F	1.8	0.6	12.8	–	–	–
							A9	H4-1	C	F	1.0	0.1	15.0	C	MD10	0.9	0.1	15.0	Yes	Yes	Yes
									LA	F	14.5	0.8	18.3	LA	F	15.0	0.7	21.4	Yes	Yes	Yes
									LA	F	3.7	0.7	5.6	LA	F	3.5	0.6	5.8	Yes	Yes	Yes
									no matching structure identified					LA	B	7.7	3.0	2.6	–	–	–
									C	MF	2.0	0.1	31.0	no matching structure identified					–	–	–
							A9	E3-3	LA	MF	9.5	0.2	58.0	LA	MF	9.0	0.1	75.0	Yes	Yes	Yes
									LA	MF	5.1	0.3	19.5	LA	MD11	5.1	0.2	25.5	Yes	Yes	Yes
									LA	MF	3.5	0.5	6.6	LA	MF	3.7	0.3	14.8	Yes	Yes	Yes
									LA	MF	4.0	0.2	17.4	LA	F	5.0	0.6	8.3	Yes	No	Yes
							A9	F3-3	LA	MF	5.5	0.5	11.1	LA	MD11	5.5	0.4	13.8	Yes	Yes	Yes
									LA	MF	3.4	0.4	8.0	LA	MD10	3.2	0.4	8.0	Yes	Yes	Yes
									LA	MF	2.6	0.2	16.0	no matching structure identified					–	–	–
									LA	F	16.4	0.9	19.2	no matching structure identified					–	–	–

TABLE 4-3
Detailed Structure Concordance Results for Recount Analyses with One or More Asbestos Structures Observed

Analysis Summary									Structure-Specific Evaluation												
					Laboratory				Original					Recount					Concordant?		
Recount Type	Index ID	Medium	Prep	Analysis Method	Original	Recount	Grid	GO	Mineral Class	Structure Type	Length (um)	Width (um)	Aspect Ratio	Mineral Class	Structure Type	Length (um)	Width (um)	Aspect Ratio	Mineral Class	Length	Width
Interlab (cont.)	SQ-00208 (cont.)	Air	Indirect	ISO	Hygeia	Batta	A10	F3-1	C	F	1.4	0.1	21.0	no matching structure identified					–	–	–
									C	F	1.5	0.1	22.5	no matching structure identified					–	–	–
									C	F	0.9	0.2	5.6	no matching structure identified					–	–	–
									LA	MF	1.9	0.2	11.6	LA	MD10	2.0	0.2	13.3	Yes	Yes	Yes
							A10	C4-2	LA	F	4.1	0.5	8.3	LA	F	3.7	0.4	10.6	Yes	Yes	Yes
									LA	F	6.3	0.8	7.9	LA	MD10	6.0	0.3	24.0	Yes	Yes	Yes
									LA	F	4.2	0.6	7.5	LA	F	4.0	0.4	10.0	Yes	Yes	Yes
									LA	F	4.4	0.1	33.5	LA	F	4.0	0.2	26.7	Yes	Yes	Yes
							A10	F4-1	C	F	7.0	0.1	106.0	C	MD11	6.7	0.1	95.7	Yes	Yes	Yes
									LA	MF	1.1	0.1	8.0	LA	MD10	4.6	0.1	46.0	Yes	No	Yes
									LA	F	1.1	0.2	6.6	LA	F	1.5	0.1	15.0	Yes	Yes	Yes
							A10	F4-4	LA	F	1.6	0.2	10.0	LA	F	1.6	0.2	10.0	–	–	–
									LA	F	19.7	0.5	42.9	LA	F	19.7	0.5	42.9	–	–	–
									LA	MF	2.0	0.2	8.6	LA	MD11	6.0	0.3	24.0	Yes	No	Yes
	SQ-00321	Air	Indirect	ISO	Batta	MAS	3	B6	LA	F	7.9	0.4	19.8	no matching structure identified					–	–	–
							3	E1	LA	F	11.4	0.5	22.8	no matching structure identified					–	–	–
									LA	F	7.8	0.25	31.2	LA	F	7.7	0.2	38.5	Yes	Yes	Yes
							3	E8	LA	B	44	1.2	36.7	LA	F	45	1.7	26.5	Yes	Yes	Yes
							3	G7	LA	F	6.2	0.65	9.5	LA	F	7.2	0.6	12.0	Yes	No	Yes
									LA	F	17.8	0.5	35.6	LA	MF	18.6	0.4	46.5	Yes	Yes	Yes
							3	I1	LA	MD10	4.6	0.2	23.0	LA	MF	6	0.4	15.0	Yes	No	Yes
									LA	F	5	1.2	4.2	LA	F	5.4	1.1	4.9	Yes	Yes	Yes
									LA	MD11	18.7	1	18.7	LA	MF	15	1.4	10.7	Yes	No	Yes
									no matching structure identified					LA	F	5	0.6	8.3	–	–	–
									no matching structure identified					LA	MF	2.4	0.2	12.0	–	–	–
							3	I3	LA	MD	11	0.7	15.7	LA	MF	6.4	0.7	9.1	Yes	No	Yes
							3	I9	LA	F	9.8	0.6	16.3	LA	F	10	0.6	16.7	Yes	Yes	Yes
							3	J8	LA	MD11	8.5	0.65	13.1	LA	MF	9	0.7	12.9	Yes	Yes	Yes
									LA	F	1.1	0.08	13.8	LA	F	0.9	0.15	6.0	Yes	Yes	Yes
							4	A7	LA	F	10.6	0.5	21.2	no matching structure identified					–	–	–
							4	B10	LA	MD10	4.8	0.18	26.7	LA	MF	4.7	0.2	23.5	Yes	Yes	Yes
							4	C8	LA	F	8.5	0.12	70.8	LA	F	9	0.2	45.0	Yes	Yes	Yes
							4	D5	LA	B	21	0.95	22.1	LA	MF	22	1.2	18.3	Yes	Yes	Yes
							4	D10	LA	F	7.8	0.45	17.3	LA	F	8	0.5	16.0	Yes	Yes	Yes
																			52/52	42/52	52/52
																			100%	*81%*	*100%*

TABLE 4-4
Repreparation Results by TEM

Index ID	SQAPP Task	Medium	Matrix	Analysis Method	Prep Method	Original					Repreparation					Poisson Rate Comparison (95% CI)
						Sensitivity	Units	Count	Conc (s/cc)	Units	Sensitivity	Units	Count	Conc (s/cc)	Units	
SQ-00009	10	Dust	HT	TEM-ISO10312	Indirect	198	$1/cm^2$	8	1.6E+03	s/cm^2	198	$1/cm^2$	8	1.6E+03	s/cm^2	Concentrations are not different
SQ-00100	2	Dust	HS & HT	ASTM	Indirect	337	$1/cm^2$	3	1.0E+03	s/cm^2	305	$1/cm^2$	0	0	s/cm^2	Concentrations are not different
SQ-00199	3B_raking	Air, Stationary	Outdoor	TEM-ISO10312	Direct	0.00099	$(cc)^{-1}$	2	2.0E-03	s/cc	0.00099	$(cc)^{-1}$	1	9.9E-04	s/cc	Concentrations are not different
SQ-00208	3B_mowing	Air, Personal	Outdoor	TEM-ISO10312	Indirect	0.0044	$(cc)^{-1}$	51	2.3E-01	s/cc	0.0059	$(cc)^{-1}$	52	3.1E-01	s/cc	Concentrations are not different
SQ-00321	3B_playing	Air, Stationary	Outdoor	TEM-ISO10312	Indirect	0.011	$(cc)^{-1}$	63	6.9E-01	s/cc	0.0034	$(cc)^{-1}$	52	1.8E-01	s/cc	Original > Reprep

HT = High traffic area
HS = Horizontal surface

TABLE 4-5
Laboratory Duplicate PLM-VE Results

Index ID	SQAPP Task	Sample Date	Sample QC Type	Sample Depth (inches)	Location Description	PLM-VE Results Original LA MF (%)	PLM-VE Results Lab Duplicate LA MF (%)	Concordance
SQ-00063	3B_mowing	22-Jun-05	Field Sample	0-2	Grids 16, 17, & 18	<1%	<1%	Concordant
SQ-00069	3B_playing	06-Jul-05	Field Sample	0-2	Horse pasture	<1%	<1%	Concordant
SQ-00150	1	27-Jun-05	Equipment Blank	--	Blank	ND	ND	Concordant
SQ-00241	1	29-Jun-05	Field Duplicate	0-6	Back, front, side yard	Trace	Trace	Concordant
SQ-00256	1	12-Jul-05	Field Sample	0-1	Back, front, side yard	Trace	Trace	Concordant
SQ-00306	3B_mowing	11-Jul-05	Field Sample	0-2	Back yard	Trace	Trace	Concordant
SQ-00315	3B_mowing	12-Jul-05	Field Sample	0-2	Forested area	Trace	Trace	Concordant
SQ-00320	3C	16-Jul-05	Field Sample	--	Stockpile	Trace	Trace	Concordant
SQ-00523	1	13-Jul-05	Field Sample	0-6	Back, front, side yard	Trace	Trace	Concordant
SQ-00599	1	26-Jul-05	Field Sample	0-6	Back, front, side yard	ND	ND	Concordant
SQ-00743	3B_mowing	16-Jul-05	Field Sample	0-2	Back yard	Trace	Trace	Concordant

TABLE 5-1. Sample Information

Location	Number of Vectors	Vegetative Cover Condition	Yard Samples		SUA Samples		High Volume Dust Samples (ft^2 sampled)
			# of Samples	# of Subsamples	# of Samples	# of Subsamples	
2098 Farm to Market Rd	3	Good	1	13	2 [b]	10	9
12 Granite Ave	2	Good	1	10	1	10	9
214 Colorado Ave	2	Good	1	10	1	8	9
1004 Wisconsin Ave	4	Good	1	12	No SUAs		9
500 Jay Effar Rd	2	Poor	2 [a]	10	SUAs not sampled [e]		9
2608 W. 2nd St Ext	2	Good	1	10	2 [b]	12	9
791 Flower Creek Rd	6	Good	1	10	1	7	9
250 Farm to Market Rd	9	Good	1	10	1	7	9
224 Forest Ave	1	Good	1	10	1	10	20 [c]
290 Granite Ave	1	Poor	1	15	1	10	12 [c]
393 Farm to Market Rd	6	Poor	1	10	No SUAs		12 [c]
35 McKay St	4	Good	1	10	1	10	9
1204 Nevada Ave	0 (vacant)	Poor	1	10	1	10	9
408 Dakota Ave	0 (vacant)	Poor	1	10	1	10	8 [d]
222 W. Larch St	2	Poor	1	10	1	10	9
3646 Highway 2 S	4	Poor	1	10	No SUAs		9
275 Dawson St	8	Good	2 [a]	15	No SUAs		9
1026 Louisiana Ave	6	Poor	1	10	1	10	9
113 Crest St	5	Poor	1	10	1	10	18 [c]
714 E. 6th St	4	Poor	1	10	1	10	9

SUA = Specific-use area soil
ft^2 = square feet
(a) Two yard samples were collected due to large size of the yard
(b) One field sample and one field duplicate
(c) Larger sampling area was needed to get required sample amount
(d) Smaller sampling area was needed to get required sample amount
(e) All SUAs covered in wood mulch

TABLE 5-2. Data Summary

Analyte	Yard or Property Soil				SUA Soil				Combined Yard-SUA Soil				Indoor House Dust			
	N	DF	Mean*	SD	N	DF	Mean*	SD	N	DF	Mean*	SD	N	DF	Mean*	SD
Antimony	20	10%	0.65	0.40	15	7%	0.66	0.40	20	9%	0.64	0.36	20	10%	3.7	3.2
Arsenic	20	100%	6.0	1.1	15	100%	5.7	1.8	20	100%	5.8	1.1	20	100%	8.2	11.4
Beryllium	20	10%	0.11	0.04	15	13%	0.13	0.06	20	11%	0.12	0.05	20	0%	0.28	0.11
Cadmium	20	20%	0.30	0.23	15	33%	0.38	0.29	20	26%	0.34	0.23	20	40%	1.2	0.84
Chromium	20	100%	15.0	9.1	15	100%	27.4	43.8	20	100%	19.8	23.0	20	100%	21.6	15.5
Copper	20	100%	19.2	9.4	15	100%	23.3	17.8	20	100%	20.9	11.0	20	100%	56.8	31.3
Lead	20	100%	41.0	91.9	15	100%	37.6	54.1	20	100%	37.9	66.7	20	100%	61.0	59.3
Nickel	20	100%	9.9	1.7	15	100%	11.8	6.3	20	100%	10.6	3.4	20	100%	16.9	15.5
Selenium	20	0%	0.35	0.09	15	7%	0.45	0.38	20	3%	0.39	0.17	20	0%	1.1	0.45
Silver	20	0%	0.20	0.006	15	0%	0.20	0.013	20	0%	0.20	0.009	20	5%	0.62	0.31
Thallium	20	0%	0.20	0.006	15	0%	0.20	0.013	20	0%	0.20	0.009	20	0%	0.57	0.23
Zinc	20	100%	88.2	78.0	15	100%	115.8	98.7	20	100%	98.6	77.3	20	100%	312.5	248.4

*Concentration Units = mg/kg
SUA = Specific-use area soil
Combined Yard-SUA Soil = Average of yard/property and SUA soil samples
N = Number of sample locations
DF = Detection frequency
SD = Standard deviation

TABLE 5-3. Yard Soil vs. SUA Soil

Analyte	p-Value*	Different?
Arsenic	0.524	No
Chromium	0.454	No
Copper	0.424	No
Lead	0.454	No
Nickel	0.358	No
Zinc	0.073	No

*All failed normality test; p-values are from Wilcoxon signed rank test.

TABLE 5-4. Ksd Results

Analyte	All Data				Outliers Excluded				
	N	K_{sd} (g soil/ cm^2)			N	K_{sd} (g soil/ cm^2)			
		Mean	SD	95^{th} Percentile		Mean	SD	95^{th} Percentile	% Excluded
Arsenic	20	0.0015	0.0018	0.0050	18	0.0011	0.0014	0.0042	10%
Chromium	20	0.0018	0.0021	0.0054	17	0.0016	0.0020	0.0053	15%
Copper	20	0.0034	0.0045	0.0100	9	0.0028	0.0029	0.0076	55%
Lead	20	0.0023	0.0025	0.0077	14	0.0024	0.0025	0.0072	30%
Nickel	20	0.0017	0.0018	0.0046	19	0.0017	0.0018	0.0047	5%
Zinc	20	0.0044	0.0072	0.0125	8	0.0039	0.0035	0.0095	60%
All	**120**	**0.0025**	**0.0039**	**0.0077**	**85**	**0.0020**	**0.0023**	**0.0069**	**29%**

SD = Standard deviation
N = Number of data
Ksd = g soil/cm^2

TABLE 6-1
Measured LA in Air and Dust for Indoor Activity-Based Sampling Scenarios

Sampling Period	Property	LA in Dust					ROUTINE ACTIVITIES									ACTIVE CLEANING ACTIVITIES									
							LA in Personal Air				LA in Stationary Air					LA in Personal Air					LA in Stationary Air				
		Index ID	Sample Type	N LA Strucs	Sensitivity $(cm^2)^{-1}$	Loading (s/cm^2)	Index ID	N LA Strucs	Sensitivity $(cc)^{-1}$	Conc (s/cc)	Index ID	Sample Type	N LA Strucs	Sensitivity $(cc)^{-1}$	Conc (s/cc)	Index ID	Sample Type	N LA Strucs	Sensitivity $(cc)^{-1}$	Conc (s/cc)	Index ID	Sample Type	N LA Strucs	Sensitivity $(cc)^{-1}$	Conc (s/cc)
Phase 2	1014 Utah Ave	2-00896		2	20	40										2-00921		0	9.54E-04	0.00E+00	2-00911	main level	1	9.52E-04	9.52E-04
																					2-00912	lower level	1	9.52E-04	9.52E-04
	1116 Utah Ave	2-00548		5	20	98	2-00071	0	7.86E-05	0.00E+00	2-00072	1st floor	2	6.66E-05	1.33E-04	2-00537	Person #1	1	1.44E-03	1.44E-03	2-00524		0	9.98E-04	0.00E+00
											2-00073	2nd floor	1	7.71E-05	7.71E-05	2-00542	Person #2	3	9.99E-04	3.00E-03					
	1218 Montana Ave	2-00863		19	20	373	2-00165	1	7.63E-05	7.63E-05	2-00166		1	7.58E-05	7.58E-05	2-00874	Person #1	0	1.73E-02	0.00E+00	2-00867		0	1.04E-03	0.00E+00
																2-00878	Person #2	2	9.82E-04	1.96E-03					
	123 Ramona Dr	2-00678		0	20	0	2-00155	8	7.06E-05	5.65E-04	2-00156	main level	5	7.83E-05	3.91E-04										
											2-00157	lower level	1	7.71E-05	7.71E-05										
	214 Colorado Ave	2-00421		11	19	214	2-00004	2	6.78E-05	1.36E-04	2-00005		2	6.39E-05	1.28E-04	2-00408	Person #1	1	3.17E-02	3.17E-02	2-00398		0	1.08E-03	0.00E+00
																2-00411	Person #2	0	2.05E-02	0.00E+00					
	218 Manor Dr	2-01051		2	19	37	2-00026	1	7.52E-05	7.52E-05	2-00027		0	7.43E-05	0.00E+00	2-01062	Person #1	0	8.18E-04	0.00E+00	2-01055		0	9.79E-04	0.00E+00
																2-01066	Person #2	0	8.18E-04	0.00E+00					
	226 Spencer Rd	2-00473		0	19	0										2-00793	Person #1	2	2.48E-02	4.95E-02	2-00476		6	8.77E-04	5.26E-03
																2-00797	Person #2	3	8.64E-04	2.59E-03					
	284 Terrace View Rd	2-00386		0	19	0										2-00379	Person #1	2	2.02E-02	4.04E-02	2-00361	main level	2	1.01E-03	2.03E-03
																2-00382	Person #2	3	9.72E-04	2.92E-03	2-00362	lower level	2	9.44E-04	1.89E-03
	3496 Highway 2 S (a)															2-00090	Person #1 (c)	7	3.54E-02	2.48E-01	2-00098	(c)	51	1.27E-03	0.00E+00
																2-00091	Person #2 (c)	0	3.41E-02	0.00E+00					
		2-00964		6	187	1123										2-00975	Person #1 (d)	0	1.02E-03	0.00E+00	2-00988	(d)	0	2.75E-02	0.00E+00
																2-00979	Person #2 (d)	0	2.69E-02	0.00E+00					
	3496 Highway 2 S (b)	2-01347	floor	3	19	58										2-01344		1	3.36E-03	3.36E-03	2-01341		3	1.34E-02	3.66E-02
		2-01346	couch	0	19	0																			
	504 Louisiana Ave	2-00456		0	19	0	2-00001	3	6.82E-05	2.05E-04	2-00002	1st floor	0	6.33E-05	0.00E+00	2-00443	Person #1	1	1.11E-03	1.11E-03	2-00429	1st floor	0	8.81E-04	0.00E+00
											2-00003	2nd floor	5	6.08E-05	3.04E-04	2-00446	Person #2	0	1.12E-03	0.00E+00	2-00430	2nd floor	1	8.47E-04	8.47E-04
	546 Granite Ave	2-00627		1	19	19	2-00247	12	7.65E-05	9.18E-04	2-00248	upper level	7	7.60E-05	5.32E-04	2-00642	Person #1	9	9.49E-04	8.54E-03	2-00632	main level	8	9.60E-04	7.68E-03
											2-00249	lower level	8	7.53E-05	6.03E-04	2-00646	Person #2	9	9.43E-04	8.49E-03	2-00633	lower level	1	9.60E-04	9.60E-04
	720 Mineral Ave (house)	2-00822		42	198	8307	2-00040	1	7.01E-05	7.01E-05	2-00041		0	9.96E-05	0.00E+00	2-00273	Person #1	3	1.21E-03	3.64E-03	2-00258		2	1.26E-03	2.96E-03
																2-00275	Person #2	2	1.25E-03	2.49E-03					
	803 Mineral Ave	2-00506		7	193	1350	2-00030	2	6.28E-05	1.26E-04	2-00031	1st floor	4	6.21E-05	2.48E-04	2-00499	Person #1	2	9.23E-02	1.85E-01	2-00485	main level	4	1.22E-03	4.69E-03
											2-00032	2nd floor	13	6.15E-05	8.00E-04	2-00502	Person #2	0	4.94E-02	0.00E+00	2-00487	upper level	4	1.23E-03	4.94E-03
	893 Greers Ferry Rd	2-01247	1st floor	14	15	204										2-01231	Person #1	1	7.85E-04	7.85E-04	2-01223	1st floor	0	8.87E-04	0.00E+00
		2-01248	2nd floor	8	193	1,547										2-01236	Person #2	2	9.77E-04	1.95E-03	2-01224	2nd floor	0	8.75E-04	0.00E+00
SQAPP	1004 Wisconsin Ave	SQ-00108		0	12	0	SQ-00115	4	6.75E-04	2.70E-03	SQ-00113		0	5.30E-05	0.00E+00										
	1016 Idaho Ave	SQ-00399		0	4	0	SQ-00367	5	1.33E-03	6.63E-03	SQ-00369		2	8.24E-05	1.65E-04										
	12 Granite Ave	SQ-00187		0	30	0	*resident did not participate*				SQ-00189		0	5.94E-05	0.00E+00										
	15 Pinewood Ln	SQ-00195		0	30	0	*resident did not participate*				SQ-00197		1	5.94E-05	5.94E-05										
	1762 Farm to Market Rd	SQ-00435		1	4	4	SQ-00439	2	6.33E-05	1.27E-04	SQ-00437		0	8.67E-05	0.00E+00										
	20 Vicks Ln	SQ-00387		14	53	742	SQ-00395	2	1.26E-03	2.51E-03	SQ-00393		0	1.71E-04	0.00E+00	*Active Cleaning Scenario not evaluated in SQAPP*									
	2098 Farm to Market Rd	SQ-00191		0	6	0	*resident did not participate*				SQ-00193		0	5.80E-05	0.00E+00										
	214 Colorado Ave	SQ-00100		3	29	88	SQ-00102	0	1.13E-04	0.00E+00	SQ-00104		0	5.94E-05	0.00E+00										
	224 Forest Ave	SQ-00183		0	4	0	*resident did not participate*				SQ-00185		0	5.94E-05	0.00E+00										
	2430 Champion Haul Rd	SQ-00441		3	4	12	SQ-00443	3	7.12E-04	2.14E-03	SQ-00445		0	7.13E-05	0.00E+00										
	2608 W. 2nd St Ext	SQ-00136		4	6	24	SQ-00138	5	1.70E-04	8.50E-04	SQ-00140		4	5.94E-05	2.38E-04										
	275 Dawson St	SQ-00359		5	28	142	SQ-00383	5	5.77E-04	2.88E-03	SQ-00385		2	1.07E-04	2.14E-04										
	35 McKays St	SQ-00381		3	29	87	SQ-00391	1	7.09E-04	7.09E-04	SQ-00389		4	8.52E-05	3.41E-04										
	393 Farm to Market Rd	SQ-00361		0	8	0	SQ-00371	1	6.62E-04	6.62E-04	SQ-00373		2	8.41E-05	1.68E-04										
	500 Jay Effar Rd	SQ-00106		2	30	61	*resident did not participate*				SQ-00110		1	5.94E-05	5.94E-05										
	815 Minnesota Ave	SQ-00499		6	5	33	SQ-00495	6	5.96E-04	3.58E-03	SQ-00497		4	8.19E-05	3.28E-04										
	842 Cabinet Heights Rd	SQ-00397		1	6	6	SQ-00363	0	8.78E-05	0.00E+00	SQ-00365		3	8.24E-05	2.47E-04										

(a) cleaning
(b) beating cushions
(c) event 1 - 3/20/01
(d) event 2 - 6/6/01

TABLE 6-2
Method 2 - Measured Dust Loading on Surfaces and in Air

Address	Index ID	Dust Sample Area (cm^2)	Dust Sample Weight (g)	Dust Loading on Surface (mg/cm^2)	Visual Observation	RAM Mean Dust in Air (ug/m^3)
214 Colorado Ave	SQ-00036	8,361	1.4	0.16	Mostly dust; small bundle of light grey fine fibrous material	10.9
1004 Wisconsin Ave	SQ-00040	8,361	4.7	0.56	1/2 dust and 1/2 fibrous material	21.5
500 Jay Effar Rd	SQ-00144	8,361	2.0	0.24	1/2 dust and 1/2 fibrous material	6.6
2608 W. 2nd St Ext	SQ-00146	8,361	7.5	0.90	Mostly dust; very little fine fibrous material; inside bottle appears to be wet; dust stuck to bottle - unable to get out all the material	42.7
224 Forest Ave	SQ-00152	18,581	0.7	0.04	1/2 dust and 1/2 fibrous material	194
2098 Farm to Market Rd	SQ-00243	8,361	5.4	0.64	1/2 dust and 1/2 fibrous material	2.6
12 Granite Ave	SQ-00247	8,361	8.7	1.04	2/3 dust and 1/3 hair ball	12.2
15 Pinewood Ln	SQ-00248	8,361	9.0	1.08	2/3 dust and 1/3 animal hair	–
275 Dawson St	SQ-00251	8,361	20.3	2.42	Mostly dust; some straw and coarse animal hair	18.1
35 McKay St	SQ-00255	8,361	2.9	0.35	Mostly dust and small hair ball	26.9
20 Vicks Ln	SQ-00258	8,361	10.9	1.30	All dust with a few animal hair	142
1016 Idaho Ave	SQ-00259	18,580	0.9	0.05	1/2 dust and 1/2 hair ball; dust stuck to bottle - unable to get out all the material	7.6
842 Cabinet Heights Rd	SQ-00260	8,361	24.5	2.93	All fine dust with a small hair ball	12.6
393 Farm to Market Rd	SQ-00525	11,148	7.6	0.68	1/2 dust and 1/2 hair ball	8.6
1762 Farm to Market Rd	SQ-00530	8,361	8.0	0.96	2/3 dust and 1/3 hair ball	13
2430 Champion Haul Rd	SQ-00531	8,361	2.6	0.31	2/3 dust and 1/3 hair ball	158
815 Minnesota Ave	SQ-00759	8,361	14.7	1.76	1/3 dust and 2/3 animal hair	17.7

– pump fault, no RAM data available

TABLE 7-1

TASK 3A: Reanalysis of Phase 2, Scenario 4 Samples

819 Cabinet Heights Rd

Personal Air

IndexID	Sample Desc.	Sample Date	Air Volume (L)	Analysis IDSeqN	Analysis Method	Prep Method	Analysis Date	GO Size (mm^2)	GO Counted	EFA (mm^2)	F-factor	Analysis Sensitivity (1/cc)	Total LA Struc	Air Conc (s/cc)	Pooled Air Conc (s/cc)
2-01187	Rototiller	8/21/2001	95	51984	TEM-AHERA	DIRECT	8/22/2001	0.0129	0	385	1	overloaded			**1.7E-01**
				13486	TEM-ISO10312	DIRECT	9/10/2001	0.0061	10	385	1	6.6E-02	**1**	**6.6E-02**	
				124385	TEM-ISO10312	DIRECT	8/31/2005	0.0058	162	385	1	4.3E-03	**40**	**1.7E-01**	
2-01191	Rototiller Asst.	8/21/2001	107	64182	TEM-AHERA	DIRECT	8/22/2001	0.0129	10	385	1	2.8E-02	0	0.0E+00	**2.9E-02**
				13489	*TEM-ISO10312*	*DIRECT*	*9/7/2001*	*0.0061*	*10*	385	1	*5.9E-02*	*0*	*0.0E+00*	
				124386	TEM-ISO10312	DIRECT	8/30/2005	0.0058	163	385	1	3.8E-03	**9**	**3.4E-02**	

Garden Soil

Index ID	Sample Desc.	Sample Date	Sample Depth	Analysis IDSeqN	Analysis Method	Analysis Date	Metric	Mineral Class	Result	Bin
1-01398	Garden Plot (G1, G2, G3)	12/9/2000	1-4 in.	23638	PLM-9002	12/13/2000	AF %	LA	ND	A
							AF %	OA	ND	A
							AF %	CHRY	ND	A
				116946	PLM-VE	11/21/2005	MF %	LA	**Tr**	**B1**
							AF %	OA	ND	A
							AF %	C	ND	A

TABLE 7-2
SQAPP TASK 3B OUTDOOR ABS DATA SUMMARY

Scenario	Location	Soil Category		TEM Results														Mean RAM Dust Level (ug/m^3)	
				Personal						Stationary									
				Adult			Child			Upwind			Downwind						
		Original Designation	PLM-VE LA Result	N LA Structures	Sensitivity (1/cc)	Total LA Air Conc. (s/cc)	N LA Structures	Sensitivity (1/cc)	Total LA Air Conc. (s/cc)	N LA Structures	Sensitivity (1/cc)	Total LA Air Conc. (s/cc)	N LA Structures	Sensitivity (1/cc)	Total LA Air Conc. (s/cc)	Upwind	Downwind
Child Playing in Dirt	1024 Montana Ave - Kootenai Valle	A (remed)	A	–	–	–	2	1.0E-03	2.0E-03	0	8.8E-04	0.0E+00	0	1.0E-03	0.0E+00	0.71	2.1
	187 Vanderwood Rd	A (remed)	A	–	–	–	0	1.0E-03	0.0E+00	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	–	2.3
	2098 Farm to Market Rd	A (remed)	A	–	–	–	0	1.1E-03	0.0E+00	0	1.0E-03	0.0E+00	0	1.1E-03	0.0E+00	3.7	5.7
	2608 W. 2nd St Ext	A (remed)	A	–	–	–	0	9.9E-04	0.0E+00	0	1.1E-03	0.0E+00	0	1.1E-03	0.0E+00	0.4	2.6
	271 Mahoney Rd	A (remed)	A	–	–	–	0	9.8E-04	0.0E+00	0	9.5E-04	0.0E+00	0	9.9E-04	0.0E+00	3.3	0.85
	500 Jay Effar Rd	A (remed)	A	–	–	–	0	7.7E-04	0.0E+00	0	9.8E-04	0.0E+00	0	9.9E-04	0.0E+00	–	–
	514 E. 8th St	A	A	–	–	–	7	2.1E-02	1.5E-01	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	5.0	12.6
	791 Flower Creek Rd	C	A	–	–	–	1	1.1E-03	1.1E-03	1	1.0E-03	1.0E-03	0	1.1E-03	0.0E+00	1.2	–
	875 Highway 2 S - Stimson Lumber	A	A	–	–	–	1	1.0E-03	1.0E-03	0	1.0E-03	0.0E+00	0	9.7E-04	0.0E+00	4.3	8.8
	1024 Montana Ave - Kootenai Valle	B1	B1	–	–	–	8	9.3E-04	7.5E-03	0	1.0E-03	0.0E+00	0	1.1E-03	0.0E+00	0.72	0.5
	514 E. 8th St	B2	B1	–	–	–	47	7.3E-03	3.4E-01	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	10.0	6.4
	875 Highway 2 S - Stimson Lumber	B1	B1	–	–	–	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	0	9.7E-04	0.0E+00	3.8	0.5
	KDC Bluffs	B2	B1	–	–	–	101	1.5E-03	1.5E-01	0	9.4E-04	0.0E+00	9	8.6E-04	7.7E-03	2.9	10.8
	224 Forest Ave	B1	B2	–	–	–	8	1.0E-03	8.0E-03	0	9.8E-04	0.0E+00	2	9.9E-04	2.0E-03	12.6	23.7
	9013 Highway 2 S	C	B2	–	–	–	7	1.0E-03	7.1E-03	0	9.6E-04	0.0E+00	4	9.3E-04	3.7E-03	1.7	5.8
	Lincoln County Landfill	A	B2	–	–	–	1	3.6E-02	3.6E-02	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	11.7	9.9
	250 Farm to Market Rd	C	C	–	–	–	51	4.4E-03	2.3E-01	0	9.6E-04	0.0E+00	0	9.5E-04	0.0E+00	3.3	1.6
Adult Raking	1024 Montana Ave - Kootenai Valle	A (remed)	A	1	8.5E-04	8.5E-04	–	–	–	0	9.7E-04	0.0E+00	1	8.8E-04	8.8E-04	–	3.9
	187 Vanderwood Rd	A (remed)	A	0	1.1E-03	0.0E+00	–	–	–	0	9.9E-04	0.0E+00	0	1.0E-03	0.0E+00	7.4	3.1
	2098 Farm to Market Rd	A (remed)	A	1	1.0E-03	1.0E-03	–	–	–	0	9.7E-04	0.0E+00	0	1.0E-03	0.0E+00	7.2	11.8
	2608 W. 2nd St Ext	A (remed)	A	0	9.9E-04	0.0E+00	–	–	–	0	1.1E-03	0.0E+00	0	1.1E-03	0.0E+00	1.7	8.2
	271 Mahoney Rd	A (remed)	A	0	9.4E-04	0.0E+00	–	–	–	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	2.2	0.2
	500 Jay Effar Rd	A (remed)	A	0	8.3E-04	0.0E+00	–	–	–	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	–	–
	514 E. 8th St	A	A	0	1.0E-03	0.0E+00	–	–	–	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	0.2	–
	791 Flower Creek Rd	C	A	0	1.0E-03	0.0E+00	–	–	–	0	1.1E-03	0.0E+00	0	1.0E-03	0.0E+00	0.8	3.0
	875 Highway 2 S - Stimson Lumber	A	A	0	1.0E-03	0.0E+00	–	–	–	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	5.8	11.5
	1024 Montana Ave - Kootenai Valle	B1	B1	36	9.2E-03	3.3E-01	–	–	–	0	1.0E-03	0.0E+00	65	2.3E-03	1.5E-01	21.5	0.85
	514 E. 8th St	B2	B1	1	1.1E-03	1.1E-03	–	–	–	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	11.6	4.04
	875 Highway 2 S - Stimson Lumber	B1	B1	1	1.0E-03	1.0E-03	–	–	–	1	1.0E-03	1.0E-03	1	9.7E-04	9.7E-04	5.6	6.64
	KDC Bluffs	B2	B1	37	1.0E-03	3.7E-02	–	–	–	18	1.1E-03	1.9E-02	0	9.4E-04	0.0E+00	9.9	11.3
	224 Forest Ave	B1	B2	0	9.9E-04	0.0E+00	–	–	–	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	2.2	2.0
	9013 Highway 2 S	C	B2	0	1.0E-03	0.0E+00	–	–	–	2	9.9E-04	2.0E-03	2	9.7E-04	1.9E-03	–	–
	Lincoln County Landfill	A	B2	3	8.4E-04	2.5E-03	–	–	–	1	9.9E-04	9.9E-04	0	9.9E-04	0.0E+00	12.4	11.5
	250 Farm to Market Rd	C	C	0	1.0E-03	0.0E+00	–	–	–	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	1.7	2.0
Lawn Mowing	1024 Montana Ave - Kootenai Valle	A (remed)	A	0	1.0E-03	0.0E+00	0	3.9E-03	0.0E+00	0	9.7E-04	0.0E+00	0	1.0E-03	0.0E+00	–	16.0
	2098 Farm to Market Rd	A (remed)	A	0	9.9E-04	0.0E+00	–	–	–	0	1.0E-03	0.0E+00	0	9.9E-04	0.0E+00	10.8	17.7
	271 Mahoney Rd	A (remed)	A	0	9.7E-04	0.0E+00	0	9.4E-04	0.0E+00	0	1.0E-03	0.0E+00	0	9.5E-04	0.0E+00	5.1	3.1
	500 Jay Effar Rd	A (remed)	A	8	1.0E-03	8.1E-03	3	9.3E-04	2.8E-03	11	9.8E-04	1.1E-02	0	3.3E-03	0.0E+00	–	–
	514 E. 8th St	A	A	3	1.0E-03	3.0E-03	15	2.2E-03	3.3E-02	0	9.8E-04	0.0E+00	0	9.8E-04	0.0E+00	20.7	82.7
	875 Highway 2 S - Stimson Lumber	A	A	0	1.0E-03	0.0E+00	1	9.6E-04	9.6E-04	0	9.9E-04	0.0E+00	1	1.0E-03	1.0E-03	10.1	23.0
	151 Vista Ave	C	B1	103	1.3E-02	1.3E+00	2	9.5E-04	1.9E-03	60	1.6E-03	7.9E-02	63	1.1E-02	6.9E-01	22.3	146.2
	187 Vanderwood Rd	A (remed)	B1	1	1.1E-03	1.1E-03	3	2.1E-03	6.4E-03	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	13.4	10.5
	224 Forest Ave	B1	B1	2	9.7E-04	1.9E-03	0	9.8E-04	0.0E+00	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	–	8.3
	2608 W. 2nd St Ext	A (remed)	B1	0	9.9E-04	0.0E+00	0	9.9E-04	0.0E+00	0	1.1E-03	0.0E+00	0	1.1E-03	0.0E+00	8.8	5.6
	514 E. 8th St	B2	B1	9	9.9E-04	8.9E-03	0	1.0E-03	0.0E+00	0	9.9E-04	0.0E+00	1	9.5E-04	9.5E-04	12.8	2.8
	791 Flower Creek Rd	C	B1	0	1.0E-03	0.0E+00	0	1.1E-03	0.0E+00	0	1.1E-03	0.0E+00	0	1.1E-03	0.0E+00	0.8	–
	875 Highway 2 S - Stimson Lumber	B1	B1	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	0	1.0E-03	0.0E+00	7.8	22.6
	Highway 37 N	B1	B1	4	1.0E-03	4.0E-03	12	1.1E-03	1.3E-02	0	1.0E-03	0.0E+00	0	9.7E-04	0.0E+00	3.4	10.4
	KDC Bluffs	B2	B1	106	3.5E-03	3.7E-01	106	1.9E-03	2.0E-01	15	1.1E-03	1.6E-02	109	2.1E-03	2.3E-01	7.7	634.4
	250 Farm to Market Rd	C	B2	9	1.1E-03	9.6E-03	7	1.1E-03	7.5E-03	0	9.7E-04	0.0E+00	5	9.7E-04	4.9E-03	3.39	10.2
	Lincoln County Landfill	A	B2	16	1.4E-03	2.3E-02	3	1.8E-02	5.5E-02	3	9.9E-04	3.0E-03	0	1.0E-03	0.0E+00	28.2	50.4

– = no sample collected

TABLE 7-3

TASK 3C: GOLF COURSE WORKER

378 Cabinet View Rd - Cabinet View Country Club

Air

IndexID	Personal/ Stationary	Sample Desc.	Sample Date	Air Volume (L)	Analysis IDSeqN	Analysis Method	Prep Method	Analysis Date	GO Size (mm^2)	GO Counted	EFA (mm^2)	F-factor	Analysis Sensitivity (1/cc)	Total LA Struc	Air Conc (s/cc)	Pooled Air Conc (s/cc)
SQ-00448	Personal (LV)*	Golf course worker	7/15/2005	1,610	124326	TEM-ISO10312	DIRECT	7/21/2005	0.011	24	385	1	9.1E-04	**4**	**3.6E-03**	**2.3E-03**
SQ-00449	Personal (HV)*	Golf course worker	7/15/2005	3,610	124327	TEM-ISO10312	DIRECT	7/21/2005	0.011	10	385	1	9.7E-04	**1**	**9.7E-04**	
SQ-00021	Personal (LV)	Laborer 1	6/13/2005	1,302	108270	TEM-ISO10312	DIRECT	6/23/2005	0.0099	40	385	1	7.5E-04	0	0.0E+00	0.0E+00
SQ-00022	Personal (LV)	Laborer 2	6/13/2005	1,302	124306	TEM-ISO10312	DIRECT	6/30/2005	0.0099	30	385	1	1.0E-03	**2**	**2.0E-03**	**2.0E-03**
SQ-00024	Personal (LV)	Laborer 1	6/14/2005	1,286	108273	TEM-ISO10312	DIRECT	6/30/2005	0.0099	30	385	1	1.0E-03	0	0.0E+00	0.0E+00
SQ-00025	Personal (LV)	Laborer 2	6/14/2005	1,286	108274	TEM-ISO10312	DIRECT	6/30/2005	0.0099	30	385	1	1.0E-03	0	0.0E+00	0.0E+00
SQ-00028	Personal (LV)	Laborer 1	6/15/2005	1,204	120191	TEM-ISO10312	DIRECT	7/5/2005	0.0099	33	385	1	9.8E-04	**3**	**2.9E-03**	**2.9E-03**
SQ-00029	Personal (LV)	Laborer 2	6/15/2005	1,187	124307	TEM-ISO10312	DIRECT	7/5/2005	0.0099	33	385	1	9.9E-04	**1**	**9.9E-04**	**9.9E-04**
SQ-00030	Stationary	Composite of downside of 3 different greens	6/15/2005	3,683	108532	TEM-ISO10312	DIRECT	7/5/2005	0.0099	11	385	1	9.6E-04	0	0.0E+00	0.0E+00
SQ-00026	Stationary	Composite of downwind side of 4 different greens	6/14/2005	2,703	108530	TEM-ISO10312	DIRECT	7/5/2005	0.0099	15	385	1	9.6E-04	0	0.0E+00	0.0E+00

HV = high volume pump
LV = low volume pump
* = Both the HV and LV samples were analyzed; results were pooled

Soil**

Index ID	Soil Category	Sample Location Desc	Sample Date	Sample Depth	PLM-VE					
					Analysis IDSeqN	Analysis Date	LA		OA	CHRY
							MF %	BIN	AF %	AF %
SQ-00320	Stockpile	Sand stockpile behind maintenance shed	7/16/2005	--	119244	8/16/2005	**Trace**	**B1**	ND	ND
SQ-00740	Stockpile	Sand stockpile by entrance road	7/16/2005	--	119245	8/16/2005	ND	A	ND	ND

**In 2004 as part of CSS, 75 surface soil samples and 1 sand stockpile sample collected from golf course - Holes #1-9 sampled (multiple tee, fairway, green samples for each hole).
For surface soil samples, 45 samples were ND (Bin A), 28 were Trace (Bin B1), and 2 were <1% (Bin B2)
For the sand stockpile sample, result was ND (Bin A)

Table 9-1 LA Results for Soil Samples Analyzed by PLM, SEM, and TEM

Zone	Index ID	Property Group Desc	Land Use	Sample Type	Location Description	PLM VE RESULT	SEM (%)	TEM (%)
1	1-02061	724 Louisiana Ave - Lincoln Play Yard	Municipal	School	Play Area	ND	0.030	0.005
	CS-18273	1711 Airstrip Rd	Residential	Yard	North side yard	ND	0	0.011
	CS-18588	875 Highway 2 S - Stimson Lumber	Commercial	Property	4 (demo derby track)	ND	0.223	0.0060
	CS-20003	378 Cabinet View Rd - Cabinet View Country Club	Commercial	Property	#9 fairway	ND	0	0.00059
2	1-02907	101 Ski Rd - Libby Middle School	Municipal	Property	Soil	ND	0.020	0.007
	1-03955	414 Indian Head Rd	Residential	Yard	yard soil	ND	0.066	0.11
	CS-16831	178 Quartz Rd	Residential	Yard	Side yard	ND	0	0.069
	CS-20160	236 N. Colorado Ave	Residential	Yard	front yard, S. side yard	ND	0	0.0023
3	CS-16939	2139 Snowshoe Rd	Residential	Yard 2	Back yard	ND	0.037	0.002
	CS-17221	136 Spencer Hill Way	Residential	Flowerbed	Front, side yard south	ND	0	0.11
	CS-17891	2180 Highway 2 S	Residential	Flowerbed	Back, front, side yard	ND	0	0.034
	CS-18203	188 Terrace View Rd	Residential	Yard	Back, front, side yard	ND	0	0.001
4	1-02163	Rainy Creek Rd	Industrial	Property	Soil	ND	0.27	0.22
	1-02175	Rainy Creek Rd	Industrial	Property	Soil	ND	1.74	0.93
5	1-03305	River Run Ln #1	Residential	Yard	yard soil	ND	0	0.017
	1-03505	155 River Run Ln	Residential	Yard	lot	ND	0	0.16
	1-03633	4241 Highway 37 N	Residential	Yard	yard soil	ND	0	0.019
	1-03903	4160 Highway 37 N Ash #1	Residential	Property	vacant lot	ND	0.14	0.021
6	1-03559	893 Greers Ferry Rd	Residential	Yard	yard soil	ND	0.097	0.15
	1D-02154	633 Greers Ferry Rd	Residential	Yard	Front yard	ND	0	0.019
	1D-02783	10 Rosa	Residential	Flowerbed	Back yard	ND	0	0.010
	CS-20118	624 Travis Rd	Residential	Property	Around house	ND	0	0.027

-- = not analyzed by this method

	SEM (%)	TEM (%)
Average (all)	0.12	0.088
Avg (excluding 1-02175)	0.042	0.048

TABLE 10-1. Summary of Properties Selected for SQAPP Tasks 6-9

Address	VAI in Intact Structure	Residual LA in Dust > 500s/cm^2	Active Use of HEPA Vacuum	Carpets as a Source
187 Vanderwood Rd		x	x	x
198 Spencer Rd Ext	x	x	x	x
411 E. 10th St	x		x	
709 E. 5th St	x	x	x	x

TABLE 10-2. Tasks 6-9 Air

Panel A. 3 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Personal/ Stationary	Height	Analysis Method	Prep Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Volume (L)	Analysis Sensitivity (1/cc)	Total N LA Structures	Total LA Conc (s/cc)
187 Vanderwood Rd	SQ-00639	9/19/2005	--	Personal	--	TEM-ISO10312	INDIRECT	103	0.011	201	0.2	5113	2E-04	1	1.73E-04
	SQ-00637	9/19/2005	Living room hallway	Stationary	n/s	TEM-ISO10312	INDIRECT	103	0.011	201	0.2	5025	2E-04	0	0.00E+00
198 Spencer Rd Ext	SQ-00633	9/15/2005	--	Personal	--	TEM-ISO10312	INDIRECT	104	0.011	201	0.15	3884	3E-04	1	3.02E-04
	SQ-00632	9/15/2005	Living room entryway	Stationary	n/s	TEM-ISO10312	DIRECT	100	0.011	385	1	5478	6E-05	3	1.92E-04
411 E. 10th St	SQ-00642	7/20/2005	--	Personal	--	TEM-ISO10312	DIRECT	100	0.01	385	1	4220	9E-05	2	1.82E-04
	SQ-00640	7/20/2005	Living room	Stationary	n/s	TEM-ISO10312	DIRECT	103	0.011	385	1	4326	8E-05	2	1.57E-04
709 E. 5th St	SQ-00620	7/19/2005	--	Personal	--	TEM-ISO10312	DIRECT	100	0.01	385	1	2610	1E-04	0	0.00E+00
	SQ-00622	7/19/2005	n/s	Stationary	n/s	TEM-ISO10312	INDIRECT	103	0.011	201	0.15	3600	3E-04	1	3.29E-04

Panel B. 12 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Personal/ Stationary	Height	Analysis Method	Prep Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Volume (L)	Analysis Sensitivity (1/cc)	Total N LA Structures	Total LA Conc (s/cc)
187 Vanderwood Rd	SQ-00668	6/7/2006	--	Personal	--	TEM-ISO10312	INDIRECT	164	0.0063	1295	0.01	5214	2E-02	0	0.00E+00
	SQ-00669	6/7/2006	Living room hallway	Stationary	Adult	TEM-ISO10312	DIRECT	100	0.0135	385	1	5851	5E-05	3	1.46E-04
	SQ-00670	6/7/2006	Living room hallway	Stationary	Child	TEM-ISO10312	DIRECT	100	0.0135	385	1	5918	5E-05	9	4.34E-04
198 Spencer Rd Ext	SQ-00672	6/8/2006	--	Personal	--	TEM-ISO10312	INDIRECT	166	0.0063	1295	0.01	2872	4E-02	0	0.00E+00
	SQ-00674	6/8/2006	Living room	Stationary	Adult	TEM-ISO10312	DIRECT	100	0.01	385	1	5751	7E-05	6	4.02E-04
	SQ-00675	6/8/2006	Living room	Stationary	Child	TEM-ISO10312	DIRECT	100	0.01	385	1	5751	7E-05	7	4.69E-04
411 E. 10th St	SQ-00648	6/9/2006	--	Personal	--	TEM-ISO10312	INDIRECT	100	0.0099	1295	0.25	2612	2E-03	0	0.00E+00
	SQ-00678	6/9/2006	Middle of living room	Stationary	Adult	TEM-ISO10312	DIRECT	100	0.011	385	1	5879	6E-05	0	0.00E+00
709 E. 5th St	SQ-00660	6/6/2006	Living room	Stationary	Adult	TEM-ISO10312	DIRECT	100	0.0135	385	1	5894	5E-05	1	4.84E-05
	SQ-00661	6/6/2006	Living room	Stationary	Child	TEM-ISO10312	INDIRECT	100	0.0135	962	0.5	5894	2E-04	0	0.00E+00
	SQ-00662	6/6/2006	--	Personal	--	TEM-ISO10312	INDIRECT	100	0.0099	1295	0.15	2940	3E-03	0	0.00E+00

Panel C. 16 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Personal/ Stationary	Height	Analysis Method	Prep Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Volume (L)	Analysis Sensitivity (1/cc)	Total N LA Structures	Total LA Conc (s/cc)
187 Vanderwood Rd	SQ-00657	9/22/2006	--	Personal	--	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	5695	3E-04	6	1.52E-03
	SQ-00658	9/22/2006	Living room hallway	Stationary	Child	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	5256	3E-04	9	2.47E-03
	SQ-00659	9/22/2006	Living room hallway	Stationary	Adult	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	5498	3E-04	3	7.87E-04
198 Spencer Rd Ext	SQ-00688	10/12/2006	--	Personal	--	TEM-ISO10312	INDIRECT - ASHED	100	0.0096	346	0.25	5250	3E-04	1	2.75E-04
	SQ-00689	10/18/2006	Living Room, Near dining room	Stationary	Adult	TEM-ISO10312	DIRECT	100	0.01	385	1	5509	7E-05	11	7.69E-04
	SQ-00690	10/18/2006	Living Room, Near dining room	Stationary	Child	TEM-ISO10312	DIRECT	100	0.01	385	1	5453	7E-05	14	9.88E-04
411 E. 10th St	SQ-00683	10/18/2006	--	Personal	--	TEM-ISO10312	DIRECT	100	0.01	385	1	4717	8E-05	0	0.00E+00
	SQ-00684	10/23/2006	Middle of living room	Stationary	n/s	TEM-ISO10312	DIRECT	100	0.01	385	1	5735	7E-05	2	1.34E-04
709 E. 5th St	SQ-00653	9/20/2006	Living room	Stationary	Child	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	5935	2E-04	1	2.43E-04
	SQ-00654	9/20/2006	Living room	Stationary	Adult	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	6056	2E-04	3	7.14E-04
	SQ-00656	9/20/2006	--	Personal	--	TEM-ISO10312	INDIRECT	100	0.0096	346	0.25	5476	3E-04	0	0.00E+00

n/s = not specified

TABLE 10-3. Tasks 6-9 Dust

Panel A. Pre-Clearance

Address	Sample ID	Sample Date	Sample Location	Sample Location Details	Analysis Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Area (cm^2)	Analysis Sensitivity (1/cm^2)	Total N LA Structures	Total LA Conc (s/cm^2)
187 Vanderwood Rd	1D-02257	10/19/2004	Ground floor	High traffic area	ASTM	4	0.0097	1295	0.15	300	742	2	1,483
	1D-02258	10/19/2004	Ground floor	Horizontal surface	ASTM	4	0.0097	1295	0.15	300	742	0	0
198 Spencer Rd Ext	1-01342	4/9/2000	Front Entry Carpet	High traffic area	TEM-ISO10312	10	0.0061	1295	0.125	300	566	0	0
	1-01343	4/9/2000	3 Separate Window Sills	Horizontal surface	TEM-ISO10312	10	0.0061	1295	0.125	300	566	0	0
	1D-02248	10/15/2004	Ground floor	High traffic area	ASTM	5	0.009	962	0.1	300	713	2	1,425
	1D-02249	10/15/2004	Ground floor	Horizontal surface	ASTM	5	0.009	962	0.1	300	713	0	0
	1D-02420	2/15/2005	Ground floor	Horizontal surface & high traffic area	ASTM	4	0.013	1295	0.2	300	415	0	0
411 E. 10th St	1-07682	3/8/2003	High traffic walkways and horizontal surfaces	Building	TEM-ISO10312	10	0.0059	1295	0.5	300	146	1	146
	1-07683	3/8/2003	High traffic walkways	Building	TEM-ISO10312	10	0.0059	1295	0.5	300	146	0	0
	1-07684	3/8/2003	Horizontal surfaces	Building	TEM-ISO10312	10	0.0059	1295	0.5	300	146	0	0
	1-07685	3/8/2003	High traffic walkways	Building	TEM-ISO10312	10	0.0059	1295	0.5	300	146	0	0
	1-07686	3/8/2003	Horizontal surfaces	Building	TEM-ISO10312	10	0.0059	1295	0.5	300	146	0	0
709 E. 5th St	1-01358	4/10/2000	Front Entry Carpet	High traffic area	TEM-ISO10312	10	0.0061	1295	0.125	300	566	1	566
	1-01359	4/10/2000	3 Separate Window Sills	Horizontal surface	TEM-ISO10312	10	0.0061	1295	0.125	300	566	0	0

Panel B. 3 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Sample Location Details	Analysis Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Area (cm^2)	Analysis Sensitivity (1/cm^2)	Total N LA Structures	Total LA Conc (s/cm^2)
187 Vanderwood Rd	SQ-00646	9/19/2005	Ground floor	Horizontal surface	ASTM	83	0.013	1295	0.05	300	80	0	0
	SQ-00647	9/19/2005	Ground floor	High traffic area	ASTM	78	0.013	1295	0.1	300	43	1	43
198 Spencer Rd Ext	SQ-00634	9/15/2005	Ground floor	Horizontal surface	ASTM	68	0.013	1295	0.25	300	20	0	0
	SQ-00635	9/15/2005	Ground floor	High traffic area	ASTM	70	0.013	1295	0.25	300	19	0	0
411 E. 10th St	SQ-00644	7/20/2005	Ground floor	Horizontal surface & high traffic area	ASTM	40	0.0135	962	0.3	300	20	2	40
709 E. 5th St	SQ-00625	7/19/2005	Ground floor	Horizontal surface & high traffic area	ASTM	100	0.0135	962	0.1	300	24	3	71

Panel C. 12 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Sample Location Details	Analysis Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Area (cm^2)	Analysis Sensitivity (1/cm^2)	Total N LA Structures	Total LA Conc (s/cm^2)
187 Vanderwood Rd	SQ-00666	6/7/2006	Ground floor	Horizontal surface & high traffic area	ASTM	14	0.011	201	0.5	300	9	0	0
198 Spencer Rd Ext	SQ-00676	6/8/2006	Ground floor	Horizontal surface & high traffic area	ASTM	16	0.011	201	0.5	300	8	0	0
411 E. 10th St	SQ-00649	6/9/2006	Ground floor	Horizontal surface & high traffic area	ASTM	16	0.011	201	0.5	300	8	0	0
709 E. 5th St	SQ-00665	6/6/2006	Ground floor	Horizontal surface & high traffic area	ASTM	16	0.011	201	0.5	300	8	0	0

Panel D. 16 Months Post-Clearance

Address	Sample ID	Sample Date	Sample Location	Sample Location Details	Analysis Method	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Area (cm^2)	Analysis Sensitivity (1/cm^2)	Total N LA Structures	Total LA Conc (s/cm^2)
187 Vanderwood Rd	SQ-00681	9/22/2006	Ground floor	Horizontal surface & high traffic area	ASTM	66	0.013	1295	0.25	300	20	1	20
198 Spencer Rd Ext	SQ-00692	10/12/2006	Ground floor	Horizontal surface & high traffic area	ASTM	77	0.013	1295	0.1	300	43	0	0
411 E. 10th St	SQ-00685	10/9/2006	Ground floor	Horizontal surface & high traffic area	ASTM	77	0.013	1295	0.1	300	43	0	0
709 E. 5th St	SQ-00651	9/20/2006	Ground floor	Horizontal surface & high traffic area	ASTM	67	0.013	1295	0.25	300	20	0	0

TABLE 10-4
DESCRIPTION OF PROPERTIES EVALUATED IN SQAPP TASKS 6-9

Attribute	187 Vanderwood Road	198 Spencer Road Extension	411 East 10th Street	709 East 5th Street
Heating System Type	Forced air & Radient heat (propane & wood stove)	Radient heat/Forced air[a] (fuel oil)	Forced air (fuel oil)	Radient heat (pellet stove, propane back-up)
Resident with former occupational exposure at property?	No (Unknown for past residents)	Yes	Yes	Yes
INTERIOR				
Interior Characterization	Dust samples – 1D-02257 (House, HT) **1,483 s/cm²** 1D-02258 (House, HS) **ND [Sens = 741]** 1D-02259 (Garage, HT & HS) **ND [Sens = 741]** 1D-02265 (Shed, HT & HS) **ND [Sens = 741]** *V+ in attic, basement*	Dust samples – 1-01342 (House, HT) **ND [Sens = 566]** 1-01343 (House, HS) **ND [Sens = 566]** *1D-02248 (House, HT)* **1,425 s/cm²** 1D-02249 (House, HS) **ND [Sens = 712]** 1D-02250 (Garden, HT & HS) **ND [Sens = 712]** 1D-02420 (House, HT & HS) **ND [Sens = 415]** Stationary air samples – 1-01317 (Living room) **ND [Sens = 0.0002]** *V+ in walls and bathroom*	Dust samples – 1-07682 (Basement, HT & HS) **146 s/cm²** 1-07683 (1st Level, HT) **ND [Sens = 146]** 1-07684 (1st Level, HS) **ND [Sens = 146]** 1-07685 (2nd Level, HT) **ND [Sens = 146]** 1-07686 (2nd Level, HS) **ND [Sens = 146]** *V+ in attic* *SIIC notes that house appears very clean*	Dust samples – 1-01358 (House, HT) **566 s/cm²** 1-01359 (House, HS) **ND [Sens = 566]** Stationary air samples – 1-01329 (Living room) **0.00041 s/cc** *V+ on ground floor (mudroom) and crawlspace*
Interior Removal?	YES	YES	YES	YES
Interior Trigger	VCI observed in attic and leaking into basement	VCI observed in bathroom	VCI observed in attic	VCI observed in mudroom and bathroom (ground floor)
Interior Removal Description	VCI removed from unfinished attic; Interior cleaning in unfinished basement	VCI removed from utility closet in ground floor bathroom; Interior cleaning not performed	VCI removed from attic space; Interior cleaning not performed	VCI removed from attic space; Soil removed from crawlspace; Interior cleaning on ground floor
Interior Contamination Remaining	None	VCI remains in exterior walls and in utility closet wall in the bathroom; Vermiculite (non-friable) identified in chimney mortar	VCI remains in chimney chase of interior wall, in east knee wall, and beneath finished floor upstairs	VCI remains in exterior and interior walls of the addition; Crawlspace, asbestos-containing soil at a depth of 12 inches BGS
EXTERIOR				
Exterior Characterization	Soil Samples – CS-04865 (Front, side yard) **VE = Trace** CS-04866 (Back yard) **VE = Trace** CS-04867 (Driveway) **VE = ND** *V+ in yard and flowerbeds (Gross V+)*	Soil Samples – 1-00959 (Driveway) **9002 & VE = ND** 1-00960 (Front yard) **9002 & VE = ND** 1-00961 (Back yard) **9002 & VE = ND** 1-00962 (Garden) **9002 = <1%** *V+ in yard and flowerbed (due to leaking VCI)*	Soil Samples – 1-04447 (yard soil) **9002 = ND** 1-04448 (yard soil) **9002 = ND** 1-04449 (flower beds) **9002 = ND** CS-08926 (Front, side yard) **9002 = ND** CS-08927 (Back yard) **9002 = ND** CS-08928 (Back, front, side yard) **9002 = ND** *No observable vermiculite outdoors*	Soil Samples – 1-01040 (Yard) **9002 & VE = ND** 1-01042 (Garden) **9002 & VE = ND** 1-01044 (Driveway) **9002 & VE = ND** CS-11549 (Back yard) **VE = ND** *Trace in front & backyard;* *V+ in side yard (due to leaking VCI)*
Exterior Removal?	YES	YES	NO	NO
Exterior Trigger	Gross V+ in yard and flowerbeds	VCI leaking from exterior walls		
Exterior Removal Description	Soil removed from yard and flowerbeds	Soil removed from yard (in a 3' band north, south, and east of property) and from flowerbed west of property		
Exterior Contamination Remaining	Side yard eastern portion of property, asbestos-containing soil at a depth of 12 inches BGS	None	None	Trace in front & backyard; not clear if VCI in side yard immediately adjacent to house (due to leaking walls) was removed as part of crawlspace removal

BGS = below ground surface
ND = non-detect
V+ = vermiculite present
HT = high traffic area
HS = horizontal surface
VCI = vermiculite-containing insulation
IFF = Information Field Form
SIIC = Supplemental Interior Information Checklist

[a] Reported information is inconsistent: IFF identifies forced air, SIIC identifies radiant heat

Table 11-1. Results for Dust Samples Collected Under Carpets

Carpet Age (yrs)	Address	Sample ID	Sample Date	Sample Location	Vectors	Grid Openings Counted	Grid Opening Size (mm^2)	EFA (mm^2)	F-Factor	Sample Area (cm^2)	Analysis Sensitivity $(cm^2)^{-1}$	Total LA Structures	Total LA Dust Loading (s/cm^2)	95% Poisson CI, Total LA Dust Loading
5-10	305 Luscher Dr	SQ-00155	6/28/2005	Basement	N	11	0.0099	1295	0.15	400	198	0	0	0 - 731
	351 Commerce Way	SQ-00013	6/16/2005	Ground floor	N	11	0.0099	1295	0.15	400	198	0	0	0 - 731
	1314 Dakota Ave	SQ-00015	6/16/2005	2nd level	S	15	0.0099	1295	0.15	300	194	0	0	0 - 715
	321 Norman Ave	SQ-00004	6/8/2005	Ground floor	S,V	22	0.0099	1295	0.15	200	198	0	0	0 - 731
10-20	404 W. 3rd St #A	SQ-00019	6/17/2005	Ground floor	N	9	0.0099	1295	0.15	500	194	0	0	0 - 715
	1014 Sheldon Flats Rd	SQ-00032	7/12/2005	Ground floor	N	22	0.0099	1295	0.15	200	198	0	0	0 - 731
	271 Mahoney Rd	SQ-00003	6/7/2005	Ground floor	S,V	9	0.0099	1295	0.15	500	194	1	194	5 - 1,080
	516 Montana Ave	SQ-00009	6/14/2005	Ground floor	S,V,W	22	0.0099	1295	0.15	200	198	8	1,586	685 - 3,124
>20	404 W. 3rd St	SQ-00017	6/17/2005	Ground floor	N	9	0.0099	1295	0.15	500	194	0	0	0 - 715
	220 Wapiti Dr	SQ-00034	6/20/2005	Ground floor	N	15	0.0099	1295	0.15	300	194	0	0	0 - 715
	250 W. Cedar St	SQ-00011	6/15/2005	Ground floor	S	15	0.0099	1295	0.15	300	194	2	388	47 - 1,400
	215 Main Ave	SQ-00007	6/10/2005	Second level	V	8	0.0099	1295	0.15	600	182	1	182	5 - 1,012

Samples were analyzed using TEM-ISO10312.

Vectors:
S = contaminated soil
V = indoor vermiculite
W = former worker
N = none

Table 12-1. Removal Activities and Sample Collection Dates for Properties Evaluated in SQAPP Task 11

Property	Removal Activities	Cleanup Start Date	Clearance Date	Post-Clearance Date
215 Main Ave	VCI from: attic, attic kneewalls, floor; interior cleaning in finished kneewall area	6/1/2005	6/8/2005	6/10/2005
1314 Dakota Ave	exterior; VCI from flooring in attic kneewalls, master bedroom, and bathroom (due to homeowner performing remodeling in these areas); interior cleaning	6/27/2005	7/5/2005	7/8/2005
807 Louisiana Ave	exterior, VCI from house and garage attics, interior cleaning in basement utility room	6/22/2005	7/5/2005	7/8/2005
1014 Louisiana Ave	exterior, VCI from attic and walls of southeast bedroom closet, interior cleaning on 2nd floor including southeast closet and east kneewall	6/20/2005	6/27/2005	6/29/2005
36 Cedar St Ext	exterior, VCI from attic and flooring, removal of exterior wall chinking, interior cleaning in basement and stairwell, encapsulate heating ducts/chimney mortar, cover over basement soils	7/6/2005	7/12/2005	7/14/2005
310 E. 5th St	exterior, VCI from attic, interior cleaning on ground floor, soil removal from crawlspace	7/5/2005	7/12/2005	7/14/2005
105 E. Cedar St - Libby Baptist Church	VCI from attic, interior cleaning on ground floor	7/11/2005	7/14/2005	7/16/2005
308 Idaho Ave	exterior, VCI from attic, interior cleaning in basement, cover over basement soils	7/12/2005	7/18/2005	7/21/2005
1705 Airstrip Rd	exterior, VCI from attic, interior cleaning on ground floor, soil removal from crawlspace	7/25/2005	8/2/2005	8/5/2005

VCI = vermiculite-containing insulation

N/A = Not applicable, clearance samples were not collected from main living area

Table 12-2. Indoor Dust Samples

Address	Sample ID	Sample Date	Sample Location	Sample Area (cm^2)	Status
215 Main Ave	SQ-00772	7/21/2005	Second level	300	Archived
807 Louisiana Ave	SQ-00766	7/20/2005	Basement	300	Archived
308 Idaho Ave	SQ-00768	7/21/2005	Basement	300	Archived
36 Cedar St Ext	SQ-00764	7/19/2005	Basement	300	Archived
1014 Louisiana Ave	SQ-00770	7/21/2005	Second level	300	Archived
1705 Airstrip Rd	SQ-00605	8/5/2005	Ground floor	300	Archived
1314 Dakota Ave	SQ-00774	7/21/2005	Second level	300	Archived
310 E. 5th St	SQ-00771	7/21/2005	Ground floor	300	Archived
105 E. Cedar St - Libby Baptist Church	SQ-00572	7/16/2005	Ground floor	300	Archived

Table 12-3. Post-Clearance Stationary Air Samples

Address	Sample ID	Sample Date	Sample Location	Sample Volume (L)	Analysis Method	Prep Method	GO Counted	GO Size (mm^2)	EFA (mm^2)	F-Factor	Analysis Sensitivity $(cc)^{-1}$	Total N LA Structures	Total LA Air Conc (s/cc)	95% Poisson CI, Total LA Air Conc
215 Main Ave	SQ-00006	6/10/2005	Second floor	6,577	TEM-ISO10312	Direct	100	0.0099	385	1	0.000059	7	0.00041	0.00017 - 0.00085
1314 Dakota Ave	SQ-00745	7/8/2005	Upstairs room	6,527	TEM-ISO10312	Direct	100	0.0101	385	1	0.000058	5	0.00029	0.00009 - 0.00068
807 Louisiana Ave	SQ-00747	7/8/2005	Basement laundry room	6,353	TEM-ISO10312	Direct	100	0.0101	385	1	0.000060	9	0.00054	0.00025 - 0.00103
1014 Louisiana Ave	SQ-00157	6/29/2005	Top of stairs in finished attic	6,571	TEM-ISO10312	Indirect	100	0.0101	1295	0.5	0.00039	2	0.00078	0.00009 - 0.00282
36 Cedar St Ext	SQ-00527	7/14/2005	Bottom of stairs in basement	6,413	TEM-ISO10312	Direct	100	0.0101	385	1	0.000059	6	0.00036	0.00013 - 0.00078
310 E. 5th St	SQ-00528	7/14/2005	Dining room	6,424	TEM-ISO10312	Direct	100	0.0101	385	1	0.000059	7	0.00042	0.00017 - 0.00086
105 E. Cedar St - Libby Baptist Church	SQ-00558	7/16/2005	Kitchen	6,311	TEM-ISO10312	Direct	100	0.0101	385	1	0.000060	0	0	0 - 0.00022
308 Idaho Ave	SQ-00769	7/21/2005	Bottom of stairs to basement	6,560	TEM-ISO10312	Direct	100	0.0101	385	1	0.000058	3	0.00017	0.00004 - 0.00051
1705 Airstrip Rd	SQ-00604	8/5/2005	Living room near entrance to bedroom	6,577	TEM-ISO10312	Direct	104	0.011	385	1	0.000051	2	0.00010	0.00001 - 0.00037

Mean Conc (s/cc): 0.00034

TABLE 13-1
SUMMARY STATISTICS FOR 404 AMBIENT AIR SAMPLES FROM LIBBY,MT

Zone	Total Samples	Total Detects	Detection Frequency	Analysis Sensitivity $(cc)^{-1}$		Air Concentration (s/cc)	
				Mean	Range (Min-Max)	Mean	Range (Min-Max)
1	108	12	11%	3.3E-03	2.0E-04 - 4.3E-02	2.2E-04	0.0E+00 - 5.2E-03
2	100	2	2%	2.9E-03	1.9E-04 - 7.1E-03	1.0E-04	0.0E+00 - 7.8E-03
3	53	2	4%	2.8E-03	2.0E-04 - 1.4E-02	1.0E-04	0.0E+00 - 5.2E-03
4	119	40	34%	1.2E-03	2.1E-04 3.7E-03	1.9E-03	0.0E+00 3.3E-02
5	24	4	17%	2.4E-03	2.9E-04 - 4.6E-03	5.3E-04	0.0E+00 - 5.2E-03
ALL	404	60	15%	2.5E-03	1.9E-04 - 4.3E-02	6.8E-04	0.0E+00 - 3.3E-02

TABLE 13-2
SUMMARY STATISTICS FOR 33 AMBIENT AIR SAMPLES SELECTED FOR REANALYSIS

PANEL A: INITIAL RESULTS

Zone	Total Samples	Total Detects	Detection Frequency	Analysis Sensitivity $(cc)^{-1}$		Air Concentration (s/cc)	
				Mean	Range (Min-Max)	Mean	Range (Min-Max)
1	11	4	36%	1.8E-03	2.5E-04 - 4.7E-03	4.8E-04	0.0E+00 - 2.7E-03
2	13	1	8%	2.7E-03	2.5E-04 - 4.6E-03	1.9E-04	0.0E+00 - 2.5E-03
3	8	1	13%	3.0E-03	8.7E-04 - 4.8E-03	2.3E-04	0.0E+00 - 1.8E-03
5	1	1	100%	4.3E-03	4.3E-03 - 4.3E-03	8.6E-03	8.6E-03 - 8.6E-03
ALL	33	7	21%	2.5E-03	2.5E-04 - 4.8E-03	5.5E-04	0.0E+00 - 8.6E-03

PANEL B: RE-ANALYSIS RESULTS

Zone	Total Samples	Total Detects	Detection Frequency	Analysis Sensitivity $(cc)^{-1}$		Air Concentration (s/cc)	
				Mean	Range (Min-Max)	Mean	Range (Min-Max)
1	11	6	55%	1.0E-04	9.9E-05 - 1.1E-04	2.2E-04	0.0E+00 - 1.1E-04
2	13	6	46%	1.0E-04	9.9E-05 - 1.2E-04	1.3E-04	0.0E+00 - 1.2E-04
3	8	2	25%	1.1E-04	9.7E-05 - 1.2E-04	9.6E-05	0.0E+00 - 1.2E-04
5	1	1	100%	9.9E-05	9.9E-05 - 9.9E-05	2.3E-03	2.3E-03 - 2.3E-03
ALL	33	15	45%	1.0E-04	9.7E-05 - 1.2E-04	2.1E-04	0.0E+00 - 1.2E-04

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity (cc)$^{-1}$	Sensitivity Range (cc)$^{-1}$
1	Screening Plant	Residential	7/4/00 - 4/17/03	568/1986	29%	2.8E-03	0.0E+00 - 5.0E-01	4E-03	4E-04 - 1E-01
3	1004 Utah Ave	Residential	4/8/03 - 4/8/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
4	102 Mineral Ave - Second Hand Store	Commercial	3/19/04 - 5/18/04	0/29	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	3E-03 - 6E-03
7	1212 Louisiana Ave	Residential	3/21/03 - 6/13/03	0/24	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 2E-02
10	1320 Louisiana Ave	Residential	4/12/04 - 4/13/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	8E-03	5E-03 - 1E-02
13	1573 Kootenai River Rd	Residential	8/14/03 - 8/20/03	0/19	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
19	203 E. Spruce St	Residential	9/20/04 - 9/22/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
20	2113 Highway 2 W	Residential	5/30/03 - 6/3/03	2/15	13%	9.0E-04	0.0E+00 - 8.8E-03	5E-03	3E-03 - 1E-02
22	2608 W. 2nd St Ext	Residential	11/9/02 - 11/18/02	0/32	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
28	35 Granite Ave	Residential	9/11/01 - 9/11/01	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
30	381 S. Central Rd	Residential	4/9/03 - 4/10/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
40	605 Utah Ave	Residential	11/2/02 - 11/2/02	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
57	Rainy Creek Rd	Industrial	11/14/00 - 11/2/02	40/96	42%	8.9E-03	0.0E+00 - 1.8E-01	3E-03	5E-04 - 5E-03
63	MillWork West	Commercial	7/28/00 - 12/6/00	70/586	12%	6.1E-04	0.0E+00 - 6.9E-02	3E-03	1E-03 - 1E-02
64	2293 Kootenai River Rd	Residential	6/17/03 - 8/7/03	2/75	3%	1.2E-04	0.0E+00 - 4.7E-03	5E-03	4E-03 - 6E-03
65	281 S. Central Rd	Residential	8/12/03 - 8/13/03	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
66	3496 Highway 2 S	Residential	7/27/01 - 11/2/01	14/562	2%	7.5E-05	0.0E+00 - 4.5E-03	4E-03	1E-03 - 6E-03
71	1020 California Ave	Residential	11/3/01 - 11/9/01	0/24	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-03	1E-03 - 5E-03
74	1108 Louisiana Ave	Residential	9/17/03 - 9/17/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
75	113 W. Oak St	Residential	10/31/03 - 11/7/03	0/14	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	3E-03 - 3E-02
79	1314 Dakota Ave	Residential	6/27/05 - 6/28/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
81	141 Conifer Rd	Residential	8/2/04 - 8/2/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
82	1511 Dakota Ave	Residential	9/12/05 - 9/26/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
83	156 S. Central Rd	Residential	8/7/02 - 8/15/02	2/27	7%	3.3E-04	0.0E+00 - 5.0E-03	4E-03	2E-03 - 6E-03
86	2098 Farm to Market Rd	Residential	5/6/03 - 5/8/03	0/12	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
87	210 W. Balsam St	Residential	5/24/05 - 5/24/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
89	259 Remps Rd	Residential	8/12/05 - 8/18/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
91	284 Terrace View Rd	Residential	7/28/04 - 7/28/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
92	31 Woodway Ave	Residential	9/19/05 - 9/20/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
99	414 Nevada Ave	Residential	9/28/04 - 9/30/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
105	546 Granite Ave	Residential	9/22/05 - 9/23/05	1/2	50%	4.6E-03	0.0E+00 - 9.2E-03	5E-03	5E-03 - 5E-03
109	622 Michigan Ave	Residential	4/16/03 - 4/23/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
111	653 Flower Creek Rd	Residential	10/9/03 - 10/14/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
112	711 California Ave - Community Health Center	Residential	12/13/01 - 12/13/01	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
113	711 Shaugnessy Hill Rd	Residential	2/22/03 - 3/4/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
114	717 Main Ave	Residential	10/7/03 - 10/8/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
115	812 W. Balsam St	Residential	10/8/03 - 10/8/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	7E-03	7E-03 - 7E-03
120	893 Greers Ferry Rd	Residential	9/21/01 - 9/27/01	2/21	10%	2.4E-04	0.0E+00 - 3.0E-03	4E-03	1E-03 - 5E-03
130	110 Montgomery Dr	Residential	6/4/02 - 10/9/03	0/9	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
133	121 W. Cedar St	Residential	9/14/04 - 9/17/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 6E-03
134	1218 Montana Ave	Residential	8/24/04 - 8/30/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
135	123 Hamann Ave	Residential	9/11/02 - 9/18/02	2/24	8%	4.0E-04	0.0E+00 - 4.8E-03	4E-03	2E-03 - 5E-03
137	1305 Dakota Ave	Residential	3/28/03 - 3/31/03	1/3	33%	1.4E-03	0.0E+00 - 4.3E-03	5E-03	4E-03 - 5E-03
138	1306 Highway 2 W	Residential	10/11/01 - 10/11/01	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
141	198 Ski Rd	Residential	8/12/05 - 8/24/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	1E-02	4E-03 - 3E-02
151	303 W. Thomas St	Residential	5/30/02 - 10/29/02	1/13	8%	3.3E-04	0.0E+00 - 4.3E-03	4E-03	3E-03 - 5E-03
154	319 Norman Ave	Residential	9/18/02 - 10/1/02	2/40	5%	2.5E-04	0.0E+00 - 8.5E-03	3E-03	2E-03 - 5E-03
155	346 Granite Ave	Residential	7/14/04 - 7/23/04	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
158	3647 Highway 2 S	Residential	7/16/03 - 7/22/03	0/23	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	3E-03 - 5E-03
162	44 Pine St	Residential	9/28/04 - 10/1/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
164	500 Jay Effar Rd	Residential	8/15/02 - 8/20/02	4/15	27%	1.7E-03	0.0E+00 - 1.6E-02	6E-03	1E-03 - 2E-02
167	505 Louisiana Ave	Residential	3/18/03 - 3/18/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
172	5878 Champion Haul Rd	Residential	4/28/01 - 4/28/01	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
173	600 Avenue B	Residential	9/7/04 - 9/21/04	0/14	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
174	609 E. 9th St - H & R Block	Residential/Commercial	5/13/05 - 5/16/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
180	781 Terrace View Rd	Residential	10/23/01 - 9/9/02	0/20	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-03	2E-03 - 5E-03
183	819 Cabinet Heights Rd	Residential	8/22/01 - 8/26/01	0/19	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 6E-03
192	150 Education Way - Libby High School	Municipal	6/19/01 - 8/29/01	26/271	10%	3.1E-04	0.0E+00 - 1.2E-02	3E-03	4E-04 - 7E-03
194	KDC Bluffs	Residential	8/10/01 - 9/26/03	105/451	23%	1.2E-03	0.0E+00 - 2.7E-02	3E-03	1E-03 - 2E-02
196	Lincoln County Landfill	Commercial	6/26/01 - 11/14/05	7/119	6%	3.1E-04	0.0E+00 - 9.8E-03	4E-03	2E-03 - 5E-03
198	101 Ski Rd - Libby Middle School	Municipal	8/22/01 - 8/26/04	17/180	9%	8.4E-04	0.0E+00 - 5.4E-02	4E-03	2E-03 - 5E-03
200	Mine Rd	Commercial	5/11/01 - 9/8/01	45/69	65%	8.2E-03	0.0E+00 - 6.7E-02	2E-03	6E-04 - 9E-03
203	Owens Property	Residential	9/18/00 - 9/20/00	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity $(cc)^{-1}$	Sensitivity Range $(cc)^{-1}$
205	247 Indian Head Rd - Plummer Elementary School	School	7/13/01 - 10/19/02	3/61	5%	1.3E-04	0.0E+00 - 4.7E-03	3E-03	1E-03 - 2E-02
211	214 Colorado Ave	Residential	10/19/00 - 10/26/00	1/5	20%	6.0E-04	0.0E+00 - 3.0E-03	3E-03	3E-03 - 4E-03
212	1417 Louisiana Ave	Residential	5/15/03 - 5/16/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
219	106 Voves Ave	Residential	7/9/03 - 7/18/03	1/30	3%	1.5E-04	0.0E+00 - 4.4E-03	5E-03	4E-03 - 2E-02
220	107 Montana Ave	Residential	10/25/04 - 10/26/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
223	1109 Louisiana Ave	Residential	3/14/03 - 3/18/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
226	115 W. 2nd St - Kootenai Angler	NA	12/5/02 - 12/14/02	0/19	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
227	1201 Utah Ave	Residential	9/23/03 - 9/23/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
233	1406 Utah Ave	Residential	8/23/04 - 8/23/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
234	141 Forest Ave	Residential	8/12/05 - 8/24/05	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
236	1417 Washington Ave	Residential	9/18/03 - 9/25/03	3/24	13%	5.7E-04	0.0E+00 - 4.9E-03	4E-03	4E-03 - 5E-03
237	1421 Main Ave	Residential	9/12/03 - 9/17/03	2/16	13%	5.4E-04	0.0E+00 - 4.3E-03	5E-03	4E-03 - 1E-02
238	154 Ski Rd	Residential	10/21/02 - 6/6/03	4/44	9%	5.2E-04	0.0E+00 - 8.9E-03	5E-03	4E-03 - 1E-02
244	191 Farm to Market Rd	Residential	10/5/04 - 10/5/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
245	198 Spencer Rd Ext	Residential	6/24/05 - 6/24/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
247	208 W. Spruce St	Residential	6/7/05 - 6/7/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
248	213 W. Balsam St	Residential	5/24/05 - 5/24/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
249	25 Evergreen St	Residential	6/4/04 - 6/11/04	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
251	310 E. 5th St	Residential	7/11/05 - 7/11/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
264	4241 Highway 37 N	Residential	10/26/02 - 11/9/02	4/48	8%	4.7E-04	0.0E+00 - 8.8E-03	5E-03	3E-03 - 3E-02
268	512 W. 6th St	Residential	10/7/04 - 10/27/04	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
271	516 Montana Ave	Residential	6/15/05 - 6/15/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
273	56 Enders Dr	Residential	10/15/04 - 10/15/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
280	6814 Highway 37 N	Residential	3/3/03 - 3/4/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	3E-03 - 5E-03
304	1124 Idaho Ave	Residential	10/11/04 - 10/13/04	1/3	33%	1.3E-03	0.0E+00 - 4.0E-03	4E-03	4E-03 - 5E-03
309	1417 Montana Ave	Residential	7/21/05 - 7/21/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
310	1421 Louisiana Ave	Residential	10/21/03 - 10/30/03	0/30	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 2E-02
311	143 Crossway Ave	Residential	6/11/03 - 6/16/03	0/14	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 6E-03
312	15 Avenue B	Residential	6/16/03 - 6/26/03	2/39	5%	2.6E-04	0.0E+00 - 5.1E-03	5E-03	3E-03 - 1E-02
319	241 Reserve Rd	Residential	8/9/05 - 8/10/05	1/2	50%	4.5E-03	0.0E+00 - 9.0E-03	5E-03	5E-03 - 5E-03
325	296 Quartz Rd	Residential	4/21/03 - 4/30/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
331	3724 Highway 2 S	Residential	10/24/05 - 10/25/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
339	506 Indian Head Rd	Residential	7/8/05 - 7/11/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	2E-02	4E-03 - 3E-02
341	52 Pearl St	Residential	5/8/03 - 5/13/03	0/9	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
344	616 W. 2nd St Ext	Residential	8/18/05 - 8/24/05	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
345	620 Dakota Ave	Residential	5/19/05 - 5/20/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
352	86 Paliga Dr	Residential	8/2/03 - 8/11/03	0/23	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
360	208 W. Balsam St	Residential	6/1/05 - 6/1/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-03	3E-03 - 3E-03
362	450 Farm to Market Rd	Residential	10/15/03 - 10/24/03	0/32	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
364	596 Jay Effar Rd	Residential	4/2/03 - 4/3/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-03	2E-03 - 4E-03
370	113 Bobtail Rd	Residential	8/1/03 - 8/25/03	2/50	4%	2.8E-04	0.0E+00 - 9.4E-03	5E-03	4E-03 - 5E-03
374	1221 Montana Ave	Residential	8/8/03 - 6/14/05	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
390	2129 Highway 2 S	Residential	4/25/03 - 5/1/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
391	221 W. Poplar St	Residential	5/2/05 - 5/2/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
408	3705 Highway 2 S	Residential	5/18/05 - 5/18/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
410	38 Spencer Hill Way	Residential	7/30/03 - 8/5/03	0/22	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
419	461 Parmenter Dr	Residential	10/14/03 - 10/15/03	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	4E-03 - 1E-02
427	519 Louisiana Ave	Residential	8/6/04 - 8/6/04	1/1	100%	4.4E-03	4.4E-03 - 4.4E-03	4E-03	4E-03 - 4E-03
432	6280 Farm to Market Rd	Residential	9/1/04 - 9/10/04	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	3E-03 - 5E-03
444	1004 Mineral Ave	Residential	10/26/04 - 10/26/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
445	1010 Mineral Ave	Residential	8/30/04 - 8/31/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
452	1108 Dakota Ave	Residential	10/8/03 - 10/9/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
469	1504 Lolo Ave	Residential	2/17/03 - 2/21/03	0/9	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
474	1604 Minnesota Ave	Residential	9/11/03 - 9/12/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
476	1705 Airstrip Rd	Residential	7/26/05 - 7/27/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
482	188 Rustic Ave	Residential	9/8/05 - 9/9/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
492	224 Forest Ave	Residential	7/19/05 - 7/22/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
493	233 W. Larch St	Residential	2/12/03 - 2/12/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
515	34 Bowker St #13	Residential	10/17/02 - 11/1/02	4/42	10%	2.6E-04	0.0E+00 - 4.2E-03	4E-03	2E-03 - 1E-02
518	3504 Highway 2 S	Residential	11/15/02 - 11/16/02	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
521	3796 Highway 2 S	Residential	9/16/03 - 9/24/03	0/12	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
522	3798 Highway 2 S	Residential	9/16/03 - 9/24/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 6E-03
524	39 Conifer Rd	Residential	10/11/05 - 10/14/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
528	409 E. 8th St	Residential	7/22/05 - 7/27/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	1E-02	4E-03 - 3E-02
529	411 Dakota Ave	Residential	9/14/04 - 9/16/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
534	46 Burr Ave	Residential	5/6/03 - 5/12/03	0/9	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity (cc)$^{-1}$	Sensitivity Range (cc)$^{-1}$
536	484 Pioneer Rd	Residential	1/18/03 - 1/23/03	0/18	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
545	5295 Highway 2 S	Residential	10/11/04 - 10/18/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
575	1024 Montana Ave - Kootenai Valley Christian Schoo	Commercial	8/22/03 - 8/10/05	1/18	6%	5.4E-04	0.0E+00 - 9.6E-03	5E-03	4E-03 - 2E-02
584	427 W. Thomas St	Residential	10/25/00 - 11/6/00	1/3	33%	1.2E-03	0.0E+00 - 3.6E-03	4E-03	4E-03 - 4E-03
587	BNSF Libby Railyard	Commercial	8/28/03 - 11/16/05	6/187	3%	1.8E-04	0.0E+00 - 1.2E-02	4E-03	2E-03 - 6E-03
589	Champion Haul Rd	Roadway	10/24/01 - 8/26/02	0/14	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	2E-03 - 5E-03
611	Screening Plant Flyway	Mine	8/22/01 - 9/7/02	8/40	20%	8.2E-04	0.0E+00 - 8.3E-03	4E-03	2E-03 - 3E-02
620	565 City Service Rd - Kootenai Valley Christian Sc	School	6/4/03 - 6/12/03	0/11	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	4E-03 - 2E-02
624	100 E. 1st St - Achievements Maintenance Shop	Commercial	12/16/02 - 12/18/02	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
628	300 Granite Ave	Residential	7/26/04 - 7/28/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
654	1217 Dakota Ave	Residential	10/21/04 - 10/25/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
658	911 Main Ave	Residential	9/27/05 - 9/28/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
661	280 S. Central Rd	Residential	6/7/02 - 6/23/03	0/21	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
664	1203 Minnesota Ave - Millwork West	Commercial	9/30/02 - 10/3/02	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	2E-03	2E-03 - 2E-03
667	875 Highway 2 S - Stimson Lumber	Commercial	7/6/04 - 6/11/05	0/56	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 1E-02
718	308 Main Ave	Residential	9/30/03 - 10/2/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
719	312 Main Ave	Residential	9/30/03 - 10/2/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
725	620 California Ave	Residential	7/29/04 - 7/29/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
729	213 Colorado Ave	Residential	11/11/03 - 11/12/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
734	1306 Louisiana Ave	Residential	3/26/03 - 4/2/03	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
742	503 Idaho Ave	Residential	8/7/03 - 8/13/03	0/20	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
752	810 Wisconsin Ave	Residential	5/4/04 - 5/5/04	1/8	13%	5.5E-04	0.0E+00 - 4.4E-03	5E-03	4E-03 - 5E-03
773	504 W. 2nd St	Residential	9/16/04 - 9/16/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
776	312 Colorado Ave	Residential	7/31/03 - 7/31/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
784	609 Idaho Ave	Residential	6/16/04 - 6/17/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
787	308 E. 2nd St - St. John's Outpatient Therapy	Commercial	8/2/05 - 9/16/05	6/114	5%	2.2E-04	0.0E+00 - 4.6E-03	4E-03	4E-03 - 5E-03
791	1403 Montana Ave	Residential	6/14/04 - 6/14/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
792	1021 Idaho Ave	Residential	9/12/03 - 9/22/03	0/28	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
798	715 Idaho Ave	Residential	4/22/03 - 4/24/03	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
801	415 W. 2nd St	Residential	9/14/04 - 9/14/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
804	519 W. 3rd St	Residential	1/31/03 - 6/7/03	2/21	10%	4.3E-04	0.0E+00 - 4.6E-03	5E-03	4E-03 - 8E-03
807	520 Idaho Ave	Residential	8/13/03 - 8/14/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	4E-03 - 7E-03
820	1311 Idaho Ave	Residential	9/29/03 - 9/29/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	6E-03 - 6E-03
822	709 Idaho Ave	Residential	9/28/04 - 9/28/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
827	1215 Idaho Ave	Residential	4/4/03 - 4/7/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
830	507 E. Lincoln Blvd	Residential	4/20/04 - 4/23/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
841	720 Michigan Ave	Residential	9/29/04 - 9/30/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
854	813 Wisconsin Ave	Residential	7/13/05 - 7/15/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
870	603 W. 10th St	Residential	3/11/03 - 6/23/03	0/22	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 1E-02
871	607 W. 10th St	Residential	3/8/03 - 6/23/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
884	607 Dakota Ave	Residential	6/24/04 - 6/25/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	3E-03 - 4E-03
886	421 W. 2nd St	Residential	8/16/05 - 8/17/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
891	1221 Louisiana Ave	Residential	9/29/04 - 10/1/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
902	1202 Louisiana Ave	Residential	8/15/03 - 8/18/03	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	4E-03 - 1E-02
904	514 E. 8th St	Residential	7/28/05 - 7/29/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
910	1113 Dakota Ave	Residential	10/2/03 - 10/3/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
911	1314 Louisiana Ave	Residential	3/26/03 - 4/2/03	1/7	14%	6.1E-04	0.0E+00 - 4.3E-03	5E-03	4E-03 - 5E-03
918	310 W. 8th St	Residential	9/30/04 - 10/1/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
926	1115 Dakota Ave	Residential	9/1/04 - 9/1/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
938	518 E. 5th St	Residential	9/29/05 - 9/30/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	2E-02	4E-03 - 4E-02
951	87 Yellowtail Rd	Residential	9/3/03 - 9/9/03	0/14	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 6E-03
957	1415 Dakota Ave	Residential	9/6/05 - 9/7/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
959	1512 Dakota Ave	Residential	9/30/03 - 10/6/03	1/20	5%	4.2E-04	0.0E+00 - 8.4E-03	4E-03	4E-03 - 5E-03
984	821 Minnesota Ave	Residential	6/17/04 - 6/17/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
985	112 W. Balsam St	Residential	5/12/05 - 5/17/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
988	502 Dakota Ave	Residential	9/19/03 - 9/22/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
989	1011 Main Ave	Residential	7/23/03 - 7/30/03	1/28	4%	1.6E-04	0.0E+00 - 4.5E-03	5E-03	4E-03 - 1E-02
1012	1204 Montana Ave	Residential	6/13/05 - 6/13/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1013	1214 Montana Ave	Residential	8/8/05 - 8/8/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1014	1302 Montana Ave	Residential	6/29/05 - 6/29/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1021	102 E. Larch St	Residential	6/21/05 - 6/21/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity $(cc)^{-1}$	Sensitivity Range $(cc)^{-1}$
1026	514 Minnesota Ave	Residential	9/16/04 - 9/20/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1030	613 Minnesota Ave	Residential	7/30/04 - 8/2/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1031	805 Minnesota Ave	Residential	7/13/04 - 7/14/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1045	418 Louisiana Ave	Residential	5/2/05 - 5/2/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1053	1414 Montana Ave	Residential	7/20/05 - 7/20/05	1/1	100%	4.1E-03	4.1E-03 - 4.1E-03	4E-03	4E-03 - 4E-03
1067	1411 1/2 Main Ave	Residential	9/20/04 - 9/20/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1069	107 W. 4th St - EMSL Lab	Commercial	9/7/02 - 9/10/02	1/3	33%	1.4E-03	0.0E+00 - 4.3E-03	2E-03	2E-03 - 2E-03
1078	116 E. Balsam St	Residential	10/4/04 - 10/4/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1081	222 E. Balsam St	Residential	8/13/04 - 8/16/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1088	621 Dakota Ave	Residential	10/3/03 - 10/6/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1090	1402 Nevada Ave	Residential	8/21/03 - 8/21/03	1/2	50%	2.5E-03	0.0E+00 - 4.9E-03	5E-03	5E-03 - 5E-03
1092	1019 Utah Ave	Residential	8/16/04 - 8/16/04	1/1	100%	4.5E-03	4.5E-03 - 4.5E-03	5E-03	5E-03 - 5E-03
1095	604 Utah Ave	Residential	5/27/05 - 5/31/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1101	1022 Utah Ave	Residential	7/16/03 - 7/16/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	1E-02	5E-03 - 2E-02
1103	205 W. Spruce St	Residential	8/24/04 - 8/25/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1106	1104 Montana Ave	Residential	7/6/05 - 7/6/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1120	1318 Nevada Ave	Residential	8/18/03 - 8/21/03	1/8	13%	7.8E-04	0.0E+00 - 6.2E-03	5E-03	4E-03 - 6E-03
1124	610 California Ave - Family Eye Care Clinic	Residential/Commercial	10/20/04 - 10/21/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1125	118 W. Poplar St	Residential	10/19/04 - 5/5/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1135	713 Michigan Ave	Residential	5/12/03 - 5/12/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1137	415 Utah Ave	Residential	9/14/04 - 9/14/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1138	111 W. Balsam St	Residential	10/19/04 - 11/4/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1156	103 W. Balsam St	Residential	10/6/04 - 10/8/04	1/3	33%	1.3E-03	0.0E+00 - 4.0E-03	4E-03	4E-03 - 5E-03
1158	1312 Nevada Ave	Residential	8/18/03 - 8/20/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	4E-03 - 8E-03
1167	1408 Montana Ave	Residential	6/16/04 - 7/11/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1169	1315 Utah Ave	Residential	11/3/03 - 11/6/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 7E-03
1177	113 W. Poplar St	Residential	6/23/04 - 6/23/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1182	1421 Utah Ave	Residential	8/10/04 - 8/10/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1185	906 W. Balsam St	Residential	6/18/04 - 6/22/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1197	1028 Montana Ave	Residential	7/8/05 - 7/8/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1199	222 W. Poplar St	Residential	11/13/03 - 11/14/03	0/7	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1203	610 Michigan Ave	Residential	5/3/04 - 5/4/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1221	1027 California Ave	Residential	8/6/03 - 8/6/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	6E-03	6E-03 - 6E-03
1225	1119 Montana Ave	Residential	6/23/05 - 6/23/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1229	1010 Washington Ave	Residential	4/14/05 - 4/14/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1236	1303 Washington Ave	Residential	7/26/03 - 4/18/05	0/9	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 7E-03
1244	509 E. 8th St	Residential	5/6/05 - 5/6/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-02	3E-02 - 3E-02
1253	210 W. Poplar St	Residential	5/16/05 - 5/16/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1261	113 W. Spruce St	Residential	6/2/05 - 6/2/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1262	917 California Ave	Residential	5/29/03 - 6/4/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1270	210 Parmenter Dr	Residential	9/12/05 - 9/12/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1272	222 W. Larch St	Residential	3/28/05 - 3/28/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1281	210 W. Oak St	Residential	3/6/03 - 3/7/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1298	1104 California Ave	Residential	7/19/03 - 7/21/03	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	7E-03	5E-03 - 9E-03
1300	1108 California Ave	Residential	7/19/03 - 7/22/03	1/7	14%	1.2E-03	0.0E+00 - 8.5E-03	1E-02	4E-03 - 2E-02
1303	1521 Utah Ave	Residential	9/8/04 - 9/9/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1308	320 Idaho Ave	Residential	5/27/05 - 5/27/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	1E-02	1E-02 - 1E-02
1317	1248 Nevada Ave	Residential	10/23/03 - 10/23/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1318	1102 Nevada Ave	Residential	11/6/03 - 11/11/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1327	518 E. 4th St	Residential	6/10/04 - 6/10/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1334	1111 Montana Ave	Residential	9/23/04 - 9/28/04	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1339	65 Glenwood Ln	Residential	9/3/03 - 9/12/03	0/28	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1343	1204 California Ave	Residential	9/30/03 - 10/3/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 8E-03
1380	341 Parmenter Dr	Residential	5/30/03 - 6/7/03	1/31	3%	1.5E-04	0.0E+00 - 4.6E-03	5E-03	4E-03 - 1E-02
1383	1323 Cabinet Ave	Residential	5/9/05 - 5/12/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1419	408 Parmenter Ave	Residential	7/27/05 - 7/29/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1427	225 W. Cedar St	Residential	7/14/05 - 7/14/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1440	407 W. Balsam St - Pioneer Park Center	Park/campground	2/13/03 - 2/24/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1441	1409 Washington Ave	Residential	4/7/05 - 4/7/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1445	108 W. Cedar St	Residential	7/8/04 - 4/8/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1446	419 Indian Head Rd	Residential	7/25/05 - 7/27/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1451	504 Klatawah St	Residential	5/18/05 - 5/18/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1455	304 Norman Ave	Residential	7/29/05 - 7/29/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1465	70 Cedar St Ext	Residential	10/13/04 - 10/13/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1466	104 Cedar St Ext	Residential	8/26/05 - 8/29/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1474	River Runs Through It	Residential	7/24/02 - 7/24/02	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity $(cc)^{-1}$	Sensitivity Range $(cc)^{-1}$
1478	1118 Montana Ave	Residential	8/5/03 - 8/6/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1491	132 Mahoney Rd	Residential	6/8/04 - 6/8/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1503	131 W. Larch St	Residential	3/25/05 - 3/25/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1504	614 W. Balsam St	Residential	9/28/04 - 10/4/04	0/11	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 8E-03
1506	1411 Montana Ave	Residential	10/5/04 - 10/6/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	9E-03	4E-03 - 1E-02
1523	1408 Washington Ave	Residential	4/26/05 - 4/26/05	1/1	100%	4.8E-03	4.8E-03 - 4.8E-03	5E-03	5E-03 - 5E-03
1567	1322 Louisiana Ave	Residential	7/9/04 - 7/12/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1579	109 W. Oak St	Residential	8/20/03 - 8/21/03	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	9E-03	5E-03 - 3E-02
1583	310 W. Flower St	Residential	4/5/03 - 4/8/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1611	136 Cedar St Ext	Residential	8/2/05 - 8/12/05	1/3	33%	1.4E-03	0.0E+00 - 4.1E-03	4E-03	4E-03 - 5E-03
1635	1411 Louisiana Ave	Residential	10/4/04 - 10/4/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1643	418 Dome Mountain Ave	Residential	8/9/05 - 8/10/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1652	1511 Gallatin Ave	Residential	5/12/05 - 5/16/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	1E-02	5E-03 - 3E-02
1671	303 W. Thomas St - former Export Plant	Commercial	9/5/01 - 11/15/01	46/264	17%	2.6E-03	0.0E+00 - 3.7E-01	3E-03	8E-04 - 5E-02
1700	305 Dome Mountain Ave	Residential	8/15/05 - 8/15/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1703	1016 California Ave	Residential	9/8/05 - 9/8/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1704	1114 California Ave	Residential	9/13/05 - 9/13/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1705	201 W. Spruce St	Residential	6/9/05 - 6/9/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1744	321 Rustic Ave	Residential	7/26/05 - 7/28/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1746	416 Indian Head Rd	Residential	8/18/05 - 8/22/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1750	415 Dome Mountain Ave	Residential	8/11/05 - 8/12/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1816	503 Klatawah St	Residential	6/30/05 - 7/6/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
1843	18 Rainbow Ln	Residential	8/18/05 - 8/22/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
1864	49 Rainbow Ln	Residential	9/14/05 - 9/14/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1887	196 Garden Rd	Residential	5/2/05 - 5/3/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
1898	162 Conifer Rd	Residential	7/11/05 - 7/11/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1944	179 Forest Ave	Residential	8/25/05 - 8/25/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
1948	257 Conifer Rd	Residential	6/7/05 - 6/9/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2012	768 Conifer Rd	Residential	8/30/05 - 8/30/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
2018	187 Vanderwood Rd	Residential	6/9/05 - 6/13/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2048	644 N. Central Rd	Residential	8/2/05 - 8/2/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
2086	14 Pioneer Rd	Residential	7/13/05 - 7/15/05	1/3	33%	1.6E-03	0.0E+00 - 4.7E-03	5E-03	4E-03 - 5E-03
2224	1211 Nevada Ave	Residential	6/3/04 - 6/3/04	1/1	100%	4.1E-03	4.1E-03 - 4.1E-03	4E-03	4E-03 - 4E-03
2301	1120 California Ave	Residential	3/12/03 - 3/12/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
2302	1118 California Ave	Residential	3/8/03 - 3/10/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2304	215 Montana Ave	Residential	8/13/04 - 8/17/04	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2308	1209 Montana Ave	Residential	6/27/05 - 7/14/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2327	1211 Washington Ave	Residential	4/15/05 - 4/15/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
2349	1304 Washington Ave	Residential	7/16/04 - 7/21/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2355	192 Cedar St Ext	Residential	9/20/05 - 9/22/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2444	43 Hamann Ave	Residential	4/10/03 - 4/12/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2501	Screening Plant Rainy Creek	Residential	8/26/02 - 8/27/02	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	3E-03	2E-03 - 4E-03
2506	28 Rainbow Ln	Residential	8/9/05 - 8/15/05	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2528	1021 Louisiana Ave	Residential	7/15/03 - 9/24/03	0/25	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2620	292 Spencer Rd	Residential	10/11/04 - 10/12/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
2621	147 Pioneer Rd	Residential	6/17/05 - 6/22/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	3E-03 - 4E-03
2637	101 Cedar Meadow Rd	Residential	5/1/03 - 5/2/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2641	807 Wisconsin Ave	Residential	10/14/04 - 10/14/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	7E-03	7E-03 - 7E-03
2642	304 Spencer Rd	Residential	10/5/04 - 10/7/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
2656	227 Quartz Rd	Residential	4/11/03 - 4/17/03	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
2781	1304 Airth Ave	Residential	5/23/05 - 5/23/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
3020	Rainy Creek Bank	Residential	9/24/02 - 10/24/02	15/104	14%	7.5E-04	0.0E+00 - 1.6E-02	4E-03	1E-03 - 5E-03
3049	480 Pioneer Rd	Residential	8/3/05 - 8/3/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
3071	4353 Champion Haul Rd	Residential	9/6/05 - 9/6/05	1/4	25%	1.2E-03	0.0E+00 - 4.9E-03	5E-03	5E-03 - 5E-03
3124	308 Parmenter Ave	Residential	9/14/05 - 9/16/05	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
3204	52 Crossroad Way	Residential	7/10/03 - 7/17/03	1/27	4%	1.6E-04	0.0E+00 - 4.2E-03	4E-03	4E-03 - 5E-03
3372	264 Vicks Dr	Residential	9/8/04 - 9/9/04	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
3375	196 Ski Rd	Residential	8/18/05 - 8/18/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
3379	494 Farm to Market Rd	Residential	5/5/05 - 5/5/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
3415	408 W. Oak St	Residential	10/13/04 - 10/21/04	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
3438	132 Upper Flower Creek Rd	Residential	2/6/03 - 2/6/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
3444	21 Wood St	Residential	7/19/05 - 7/19/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
3493	430 Terrace View Rd	Residential	7/21/04 - 7/26/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
3540	28 Evergreen St	Residential	7/11/05 - 7/11/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
3759	1325 Airstrip Rd	Residential	7/9/03 - 7/12/03	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
4004	Rainy Creek Rd/ Rainy Creek Banks	*Commercial*	*10/7/02 - 10/24/02*	*1/15*	*7%*	*3.2E-04*	*0.0E+00 - 4.8E-03*	*4E-03*	*4E-03 - 5E-03*

TABLE 14-1
PERIMETER AIR SUMMARY STATISTICS BY PROPERTY

Property ID	Address	Land Use	Sampling Date Range	Detection Frequency		Mean Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity $(cc)^{-1}$	Sensitivity Range $(cc)^{-1}$
4025	1302 Airth Ave	Residential	9/3/03 - 9/15/03	1/31	3%	1.4E-04	0.0E+00 - 4.3E-03	4E-03	4E-03 - 5E-03
4136	525 Spencer Rd Ext - Granite Concrete Co. Inc.	Commercial	4/17/03 - 4/18/03	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
4171	525 Spencer Rd Ext	Commercial	4/21/03 - 4/21/03	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
4187	1609 Airstrip Rd	Residential	9/26/05 - 9/28/05	1/3	33%	3.1E-03	0.0E+00 - 9.3E-03	4E-03	4E-03 - 5E-03
4191	3111 Champion Haul Rd	Residential	9/22/04 - 9/27/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
4200	5000 Highway 37 N - former Screening Plant	Commercial	6/13/03 - 8/12/04	4/32	13%	6.0E-04	0.0E+00 - 4.9E-03	5E-03	3E-03 - 2E-02
4201	125 W. Cedar St	Residential	10/21/05 - 10/25/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
4215	569 E. Thomas St	Residential	10/21/04 - 11/3/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	3E-03 - 4E-03
4228	4297 Highway 2 W	Residential	10/4/04 - 10/11/04	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
4255	KDC Flyway	Industrial	7/15/01 - 8/5/04	192/829	23%	1.4E-03	0.0E+00 - 2.9E-02	3E-03	9E-04 - 9E-03
4310	119 W. Oak St	Residential	10/7/04 - 10/7/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
4334	6683 Farm to Market Rd	Residential	8/4/05 - 8/15/05	0/8	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
4403	1213 Louisiana Ave	Residential	9/21/04 - 9/24/04	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 5E-03
4529	Riverside Park	Park	10/1/03 - 11/13/03	4/119	3%	1.5E-04	0.0E+00 - 4.6E-03	4E-03	3E-03 - 5E-03
4532	46 Crossway Ave	Residential	10/4/05 - 10/5/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
4542	4526 Highway 2 W	Residential	5/19/05 - 5/19/05	0/4	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
4587	J. Neils Park	Park	5/10/05 - 9/20/05	0/17	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	4E-03 - 5E-03
4712	City of Libby Alley	Residential	8/30/05 - 8/31/05	3/30	10%	9.7E-05	0.0E+00 - 1.0E-03	3E-03	1E-03 - 4E-03
4801	Frontage S. of Rainy Creek Rd	Residential	11/17/03 - 11/18/03	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
4812	Rainy Creek Rd - S Frontage	Residential	11/10/03 - 8/20/04	2/49	4%	1.6E-04	0.0E+00 - 4.4E-03	4E-03	4E-03 - 5E-03
4813	Rainy Creek Rd - N Frontage	Residential	11/4/03 - 8/30/04	5/34	15%	9.2E-04	0.0E+00 - 8.7E-03	5E-03	4E-03 - 5E-03
4894	Highway 37 N	Borrow Source	6/2/05 - 6/17/05	1/34	3%	1.3E-04	0.0E+00 - 4.4E-03	4E-03	4E-03 - 5E-03
4897	1426 Idaho Ave	Residential	7/21/04 - 7/27/04	0/5	0%	0.0E+00	0.0E+00 - 0.0E+00	4E-03	4E-03 - 4E-03
4927	150 Mahoney Rd	Residential	10/14/04 - 10/14/04	1/1	100%	4.5E-03	4.5E-03 - 4.5E-03	5E-03	5E-03 - 5E-03
4941	4000 Pipe Creek Rd	Commercial	1/7/05 - 1/7/05	1/4	25%	7.0E-03	0.0E+00 - 2.8E-02	4E-03	2E-03 - 5E-03
4948	Highway 37 N - Right of Way	Roadway	5/23/05 - 5/23/05	0/10	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
4969	1309 Washington Ave	Residential	4/12/05 - 4/20/05	0/2	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
5344	277 Rustic Rd		8/3/05 - 8/3/05	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	5E-03	5E-03 - 5E-03
5384	404 E. 6th St	Residential	6/14/05 - 6/16/05	1/3	33%	1.6E-03	0.0E+00 - 4.7E-03	5E-03	4E-03 - 5E-03

Reported air concentrations based on total LA structures by TEM.

TABLE 14-2
PERIMETER AIR SUMMARY STATISTICS BY YEAR

Year	Detection Frequency		Analysis Sensitivity $(cc)^{-1}$		TEM Total LA Air Conc (s/cc)	
			Mean	Range (Min-Max)	Mean	Range (Min-Max)
2000	176/1412	12%	4.1E-03	1.3E-03 - 1.4E-02	9.8E-04	0.0E+00 - 6.9E-02
2001	942/3973	24%	3.5E-03	4.0E-04 - 1.2E-01	2.1E-03	0.0E+00 - 5.0E-01
2002	57/535	11%	4.1E-03	1.3E-03 - 3.1E-02	6.6E-04	0.0E+00 - 3.7E-02
2003	37/1509	2%	4.7E-03	1.7E-03 - 3.0E-02	1.3E-04	0.0E+00 - 9.6E-03
2004	25/555	5%	4.3E-03	1.7E-03 - 1.5E-02	2.2E-04	0.0E+00 - 1.2E-02
2005	23/526	4%	4.7E-03	9.5E-04 - 4.0E-02	2.6E-04	0.0E+00 - 2.8E-02
2000-2002	1175/5920	20%	3.7E-03	4.0E-04 - 1.2E-01	1.7E-03	0.0E+00 - 5.0E-01
2003-2005	85/2590	3%	4.6E-03	9.5E-04 - 4.0E-02	1.7E-04	0.0E+00 - 2.8E-02
all years	1260/8510	15%	4.0E-03	4.0E-04 - 1.2E-01	1.2E-03	0.0E+00 - 5.0E-01

Reported air concentrations based on total LA structures by TEM.

TABLE 14-3
STRATIFICATION OF SELECTED PROPERITES
FOR RE-ANALYSIS OF PERIMETER AIR SAMPLES

<table>
<tr><th rowspan="2">LA Level in Soil</th><th colspan="2">Extent of Soil Removal</th></tr>
<tr><th>"Small" (< 1000 cy)</th><th>"Large" (≥ 1000 cy)</th></tr>
<tr><td>"Low" (< 1%)</td><td><u>Group A:</u>
312 Main Ave
341 Parmenter Dr
3647 Highway 2 S
507 E. Lincoln Blvd
610 Michigan Ave</td><td><u>Group C:</u>
102 Mineral Ave - Second Hand Store
2293 Kootenai River Rd
KDC Flyway
Riverside Park</td></tr>
<tr><td>"High" (≥ 1%)</td><td><u>Group B:</u>
123 Hamann Ave
1573 Kootenai River Rd
319 Norman Ave
500 Jay Effar Rd
781 Terrace View Rd</td><td><u>Group D:</u>
101 Ski Rd - Libby Middle School
150 Education Way - Libby High School
247 Indian Head Rd - Plummer Elementary School
303 W. Thomas St - former Export Plant
BNSF Libby Railyard
Champion Haul Rd</td></tr>
</table>

cy = cubic yards

TABLE 14-4
PERIMETER AIR SAMPLE SUMMARY FOR 20 PROPERTIES

Group	Property Address	Original Results (N=1,221 samples)						
		Sampling Date Range	Detection Frequency		Total LA Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity (cc)$^{-1}$	Sensitivity Range (cc)$^{-1}$
A	312 Main Ave	9/30/03-10/2/03	0/6	0%	0.0E+00	0.0E+00 - 0.0E+00	4.4E-03	4.2E-03 - 4.6E-03
A	341 Parmenter Dr	5/30/03-6/7/03	1/31	3%	1.5E-04	0.0E+00 - 4.6E-03	5.3E-03	3.6E-03 - 1.3E-02
A	3647 Highway 2 S	7/16/03-7/22/03	0/23	0%	0.0E+00	0.0E+00 - 0.0E+00	4.5E-03	3.4E-03 - 4.9E-03
A	507 E. Lincoln Blvd	4/20/04-4/23/04	0/3	0%	0.0E+00	0.0E+00 - 0.0E+00	4.6E-03	4.6E-03 - 4.6E-03
A	610 Michigan Ave	5/4/04-5/4/04	0/1	0%	0.0E+00	0.0E+00 - 0.0E+00	4.1E-03	4.1E-03 - 4.1E-03
A	All properties in Group A		1/64	2%	7.3E-05	0.0E+00 - 4.6E-03	4.9E-03	3.4E-03 - 1.3E-02
B	123 Hamann Ave	9/4/02-9/18/02	1/25	4%	1.9E-04	0.0E+00 - 4.8E-03	3.8E-03	1.7E-03 - 4.8E-03
B	1573 Kootenai River Rd	8/14/03-8/20/03	0/19	0%	0.0E+00	0.0E+00 - 0.0E+00	4.3E-03	4.0E-03 - 4.8E-03
B	319 Norman Ave	9/10/02-10/1/02	1/44	2%	3.7E-05	0.0E+00 - 1.6E-03	3.1E-03	1.6E-03 - 5.0E-03
B	500 Jay Effar Rd	8/15/02-8/20/02	0/16	0%	0.0E+00	0.0E+00 - 0.0E+00	6.2E-03	1.3E-03 - 2.4E-02
B	781 Terrace View Rd	8/28/02-9/9/02	0/20	0%	0.0E+00	0.0E+00 - 0.0E+00	2.2E-03	9.4E-05 - 2.5E-03
B	All properties in Group B		2/124	2%	5.2E-05	0.0E+00 - 4.8E-03	3.7E-03	9.4E-05 - 2.4E-02
C	102 Mineral Ave - Second Hand Store	3/19/04-5/18/04	0/29	0%	0.0E+00	0.0E+00 - 0.0E+00	4.5E-03	3.5E-03 - 6.2E-03
C	2293 Kootenai River Rd	6/16/03-8/7/03	1/79	1%	5.9E-05	0.0E+00 - 4.7E-03	4.5E-03	3.0E-03 - 6.2E-03
C	KDC Flyway	7/15/04-8/5/04	0/20	0%	0.0E+00	0.0E+00 - 0.0E+00	4.4E-03	4.1E-03 - 5.3E-03
C	Riverside Park	10/1/03-11/13/03	2/119	2%	7.2E-05	0.0E+00 - 4.4E-03	4.5E-03	3.4E-03 - 4.9E-03
C	All properties in Group C		3/247	1%	5.4E-05	0.0E+00 - 4.7E-03	4.5E-03	3.0E-03 - 6.2E-03
D	101 Ski Rd - Libby Middle School	8/9/01-8/26/04	10/47	21%	1.3E-03	0.0E+00 - 2.7E-02	3.4E-03	9.7E-05 - 4.7E-03
D	150 Education Way - Libby High School	7/26/01-8/29/01	20/239	8%	2.6E-04	0.0E+00 - 9.4E-03	3.3E-03	4.0E-04 - 7.1E-03
D	247 Indian Head Rd - Plummer Elementary School	7/10/00-10/19/02	2/57	4%	5.7E-05	0.0E+00 - 1.9E-03	2.8E-03	9.5E-05 - 1.6E-02
D	303 W. Thomas St - former Export Plant	9/5/01-10/24/01	47/236	20%	2.9E-03	0.0E+00 - 3.7E-01	2.8E-03	7.6E-04 - 5.4E-02
D	BNSF Libby Railyard	8/28/03-10/20/04	2/194	1%	6.3E-05	0.0E+00 - 8.3E-03	4.0E-03	1.7E-03 - 6.2E-03
D	Champion Haul Rd	10/24/01-8/26/02	0/13	0%	0.0E+00	0.0E+00 - 0.0E+00	4.1E-03	2.3E-03 - 4.9E-03
D	All properties in Group D		81/786	10%	1.1E-03	0.0E+00 - 3.7E-01	3.3E-03	9.5E-05 - 5.4E-02
	All properties in Groups A-D		87/1221	7%	7.0E-04	0.0E+00 - 3.7E-01	3.7E-03	9.4E-05 - 5.4E-02

Reported air concentrations based on total LA structures by TEM.

Group A: Low LA Soil Level (< 1%), Small Removal Size (< 1000 cy)
Group B: High LA Soil Level (≥ 1%), Small Removal Size (< 1000 cy)
Group C: Low LA Soil Level (< 1%), Large Removal Size (≥ 1000 cy)
Group D: High LA Soil Level (≥ 1%), Large Removal Size (≥ 1000 cy)

TABLE 14-5
LIST OF PERIMETER AIR SAMPLES SELECTED FOR REANALYSIS

Group	Soil Level	Removal Size	Sample #	Index ID	Property Address	Total LA Conc. (s/cc)
A	Low	Small	1	1R-23353	312 Main Ave	non-detect
	(<1%)	(<1000 cy)	2	1R-20293	341 Parmenter Dr	non-detect
			3	1R-20474	341 Parmenter Dr	non-detect
			4	1R-21709	3647 Highway 2 S	4.7E-03
			5	1R-23932	507 E. Lincoln Blvd	non-detect
B	High	Small	6	1R-15255	123 Hamann Ave	9.5E-03
	(>1%)	(<1000 cy)	7	1R-22518	1573 Kootenai River Rd	4.3E-03
			8	1R-15326	319 Norman Ave	non-detect
			9	1R-15481*	319 Norman Ave	non-detect
			10	1R-14423	500 Jay Effar Rd	non-detect
			11	1R-14948	781 Terrace View Rd	non-detect
C	Low	Large	12	1R-23944	102 Mineral Ave - Second Hand Store	non-detect
	(<1%)	(>1000 cy)	13	1R-21042	2293 Kootenai River Rd	4.0E-03
			14	1R-25578	KDC Flyway	non-detect
			15	1R-24103	Riverside Park	non-detect
D	High	Large	16	1R-08094	101 Ski Rd - Libby Middle School	non-detect
	(>1%)	(>1000 cy)	17	1R-06643	150 Education Way - Libby High School	2.0E-03
			18	1R-05992	247 Indian Head Rd - Plummer Elementary School	3.9E-03
			19	1R-06211	247 Indian Head Rd - Plummer Elementary School	non-detect
			20	1R-10157**	303 W. Thomas St - former Export Plant	non-detect

* This sample was incorrectly classified as Group C in SQAPP Table 5 (revised).
** This sample replaced BN-00441 from Burlington Northern Railyard (not enough filter was available to perform re-analysis).

TABLE 14-6

SUMMARY STATISTICS FOR PERIMETER AIR SAMPLES SELECTED FOR RE-ANALYSIS

PANEL A: ORIGINAL RESULTS

Group	Total Samples	Total Detects	Detection Frequency	TEM LA Air Concentration (s/cc)		Analysis Sensitivity (cc)$^{-1}$	
				Mean	Range (Min-Max)	Mean	Range (Min-Max)
A	5	1	1/5	9.4E-04	0.0E+00 - 4.7E-03	4.6E-03	4.2E-03 - 4.8E-03
B	6	2	2/6	2.3E-03	0.0E+00 - 9.5E-03	3.8E-03	2.1E-03 - 4.8E-03
C	4	1	1/4	9.9E-04	0.0E+00 - 4.0E-03	4.3E-03	4.0E-03 - 4.6E-03
D	5	2	2/5	1.2E-03	0.0E+00 - 4.4E-03	2.3E-03	1.4E-03 - 4.6E-03
ALL	20	6	6/20	1.4E-03	0.0E+00 - 9.5E-03	3.7E-03	1.4E-03 - 4.8E-03

PANEL B: RE-ANALYSIS RESULTS [a]

Group	Total Samples	Total Detects	Detection Frequency	TEM LA Air Concentration (s/cc)		Analysis Sensitivity (cc)$^{-1}$	
				Mean	Range (Min-Max)	Mean	Range (Min-Max)
A	5	1	1/5	1.8E-04	0.0E+00 - 0.0E+00	8.7E-04	8.4E-04 - 8.9E-04
B	6	3	3/6	5.7E-04	0.0E+00 - 1.0E-03	8.1E-04	7.0E-04 - 8.9E-04
C	4	2	2/4	6.5E-04	0.0E+00 - 1.1E-03	8.6E-04	8.4E-04 - 8.8E-04
D	5	4	4/5	6.7E-04	0.0E+00 - 1.2E-03	7.1E-04	6.3E-04 - 8.8E-04
ALL	20	10	10/20	5.1E-04	0.0E+00 - 1.2E-03	8.1E-04	6.3E-04 - 8.9E-04

[a] Pooled across the original analysis results and the supplemental re-analysis results.

Group A: Low LA Soil Level (< 1%), Small Removal Size (< 1000 cy)
Group B: High LA Soil Level (≥ 1%), Small Removal Size (< 1000 cy)
Group C: Low LA Soil Level (< 1%), Large Removal Size (≥ 1000 cy)
Group D: High LA Soil Level (≥ 1%), Large Removal Size (≥ 1000 cy)

TABLE 14-7
COMPARISON OF LA LEVELS IN PERIMETER AND AMBIENT AIR

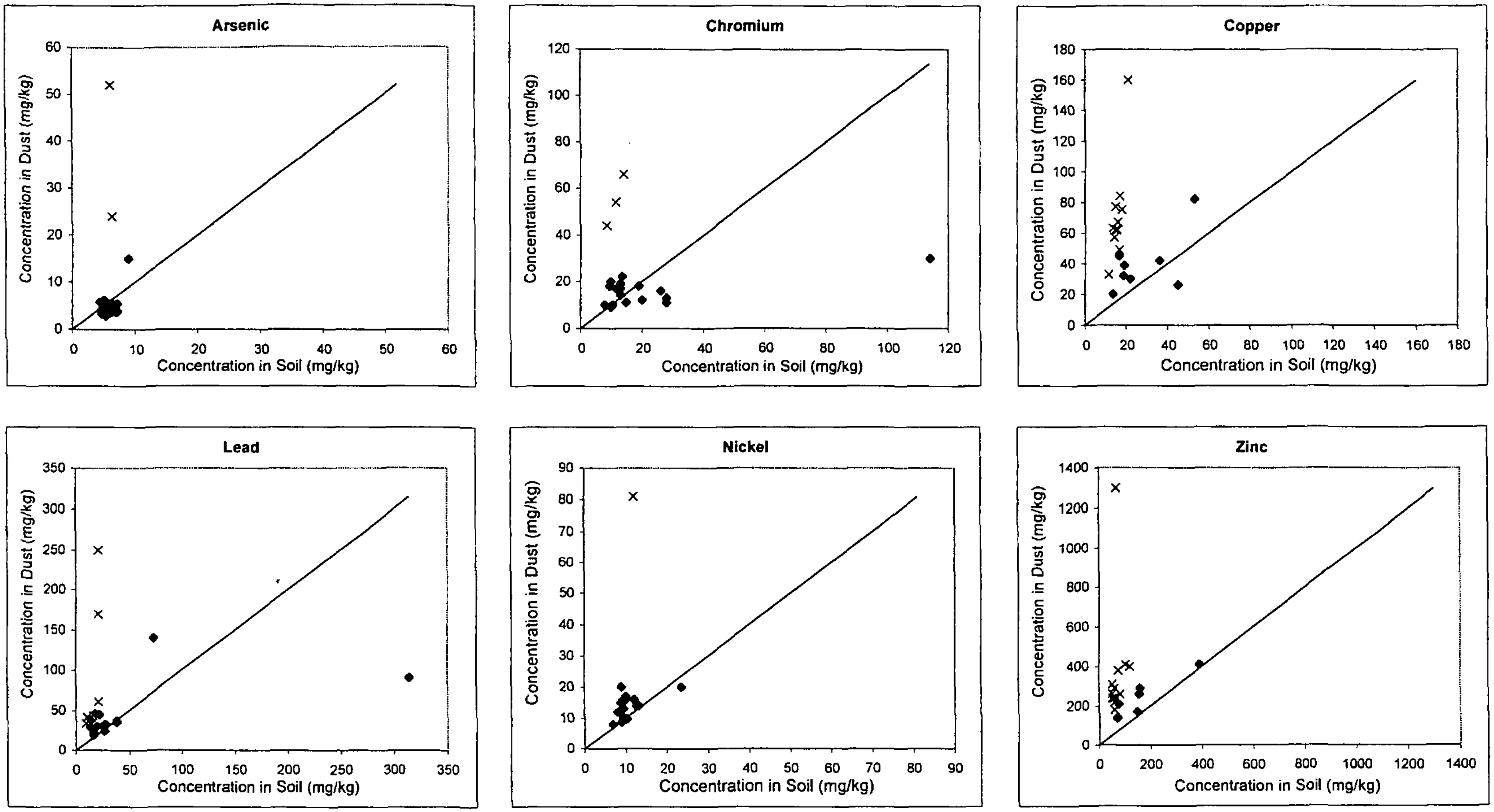
Air Sample Type	Group	Detection Frequency		Mean TEM LA Air Conc. (s/cc)	Air Conc. Range (s/cc)	Mean Sensitivity $(cc)^{-1}$	Sensitivity Range $(cc)^{-1}$
Ambient	--	16/33	48%	2.1E-04	0.0E+00 - 1.2E-04	1.0E-04	9.7E-05 - 1.2E-04
Perimeter	A	1/5	20%	1.8E-04	0.0E+00 - 0.0E+00	8.7E-04	8.4E-04 - 8.9E-04
	B	3/6	50%	5.7E-04	0.0E+00 - 1.0E-03	8.1E-04	7.0E-04 - 8.9E-04
	C	2/4	50%	6.5E-04	0.0E+00 - 1.1E-03	8.6E-04	8.4E-04 - 8.8E-04
	D	4/5	80%	6.7E-04	0.0E+00 - 1.2E-03	7.1E-04	6.3E-04 - 8.8E-04
	All	10/20	50%	5.1E-04	0.0E+00 - 1.2E-03	8.1E-04	6.3E-04 - 8.9E-04

Reported air concentrations based on total LA structures by TEM.

Group A: Low LA Soil Level (< 1%), Small Removal Size (< 1000 cy)
Group B: High LA Soil Level (≥ 1%), Small Removal Size (< 1000 cy)
Group C: Low LA Soil Level (< 1%), Large Removal Size (≥ 1000 cy)
Group D: High LA Soil Level (≥ 1%), Large Removal Size (≥ 1000 cy)

FIGURES

FIGURE 5-1. Dust vs. Soil



- ◆ Non-outliers
- × Outliers
- —— Identity

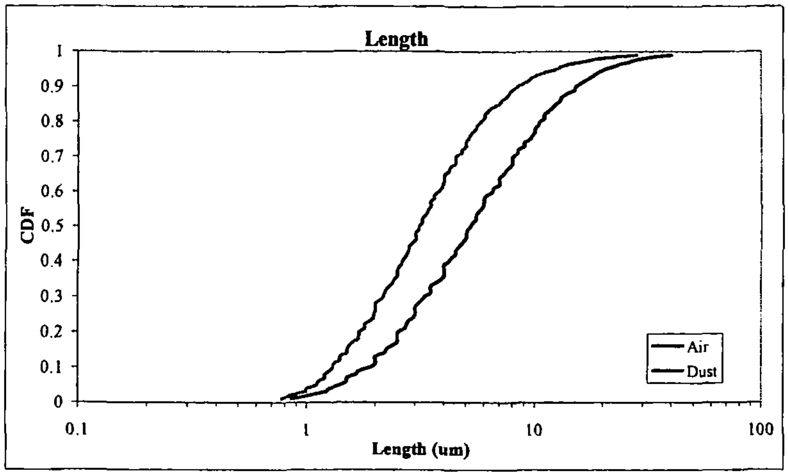
Soil = Average of yard/property and SUA soil samples
Outliers = All samples where Cdust > 2.8 * Csoil (see Appendix 5.2)

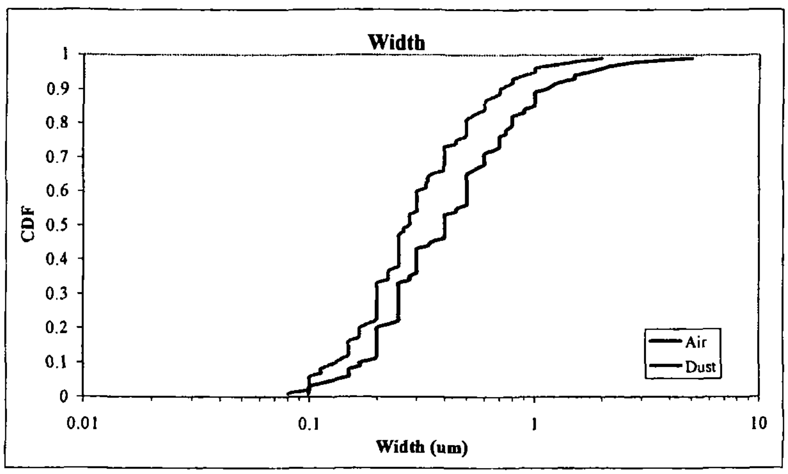
FIGURE 6-1

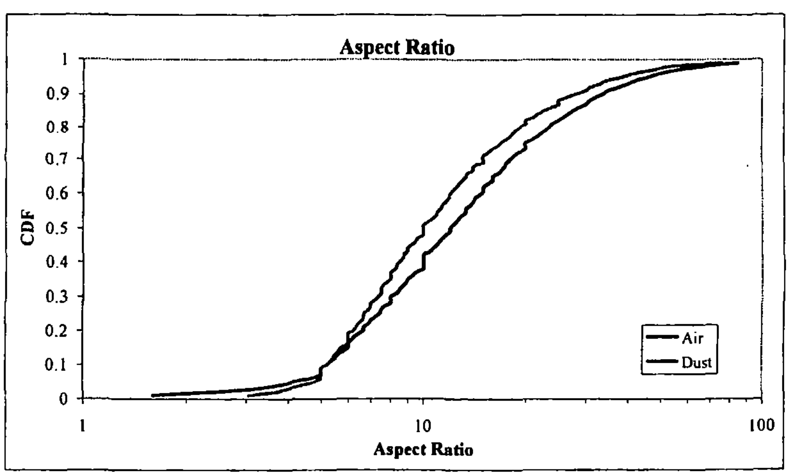
LA Particle Size Distribution

Dataset 1 = Air N= 18,949 structures

Dataset 2 = Dust N= 2,665 structures





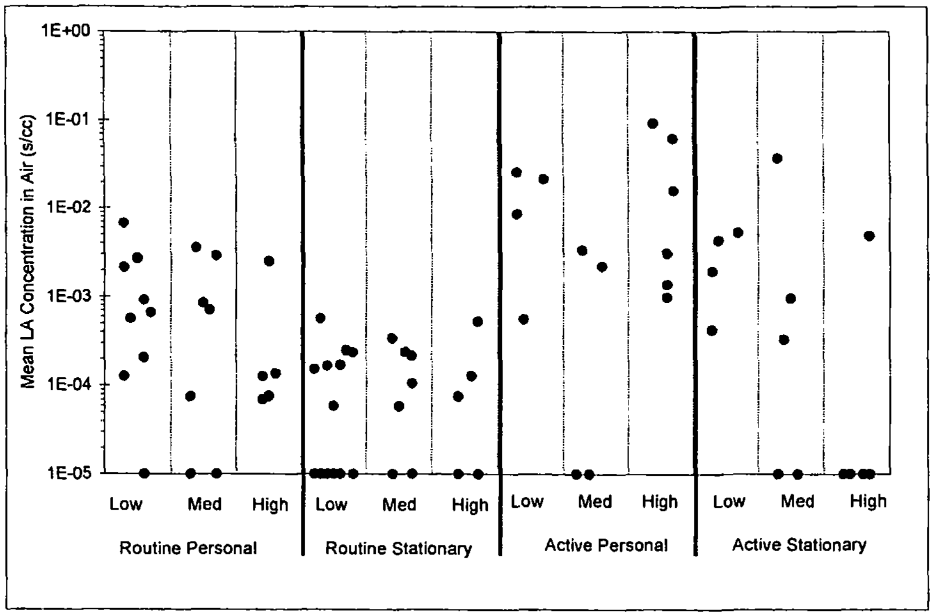


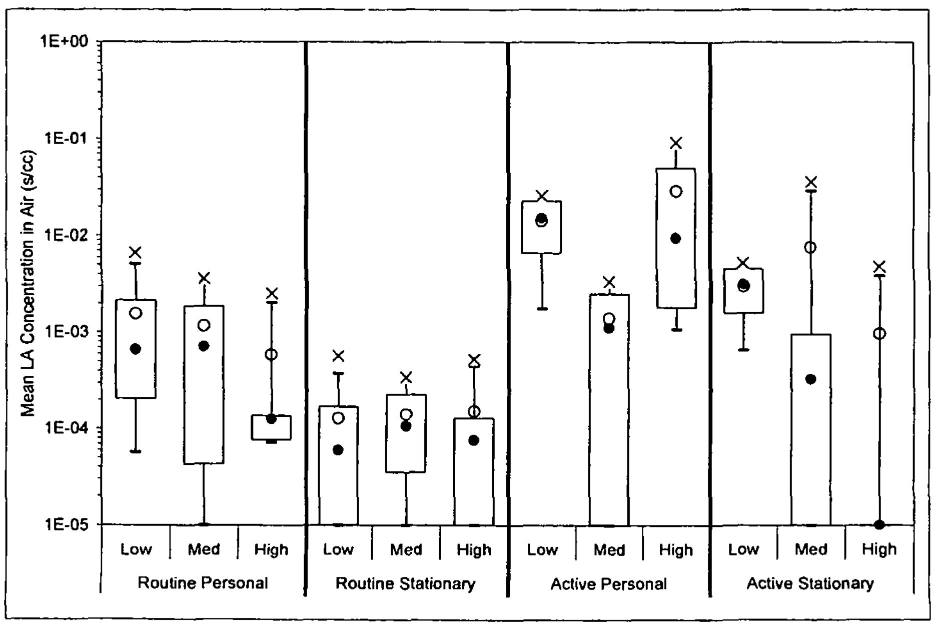
Based on Libby 2DB Download performed 2/1/2007.

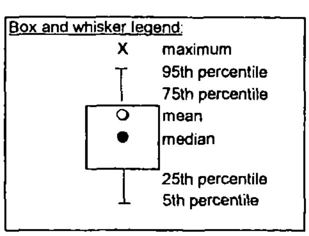
	Air		
	Length	Width	AR
95th percentile	20.50	1.75	46.00
75th percentile	9.50	0.70	20.00
50th percentile	5.20	0.40	12.00
25th percentile	3.00	0.25	7 45
5th percentile	1.40	0.13	4.17

	Dust		
	Length	Width	AR
95th percentile	12.50	1.00	38.67
75th percentile	5.07	0.45	17.00
50th percentile	3.10	0.28	10.00
25th percentile	1.97	0 20	6.70
5th percentile	1.10	0.10	4.80

FIGURE 6-2. SQAPP Task 2: Cdust vs. Cair for Indoor ABS Scenarios







Dust Level:

Low	LA < 20 s/cm^2
Medium	20 s/cm^2 < LA < 200 s/cm^2
High	LA > 200 s/cm^2

Statistic	ROUTINE ACTIVITIES						ACTIVE CLEANING ACTIVITIES					
	PERSONAL			STATIONARY			PERSONAL			STATIONARY		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
N properties	9	7	5	13	7	5	4	4	6	4	5	5
Mean	1 55E-03	1.16E-03	5.84E-04	1.27E-04	1.40E-04	1.50E-04	1.42E-02	1.40E-03	2.92E-02	2.99E-03	7.57E-03	9.70E-04
Maximum	6.63E-03	3.58E-03	2.51E-03	5.67E-04	3.41E-04	5.24E-04	2.60E-02	3.36E-03	9.23E-02	5.26E-03	3.66E-02	4.81E-03
95th percentile	5.06E-03	3.37E-03	2.04E-03	3.75E-04	3.10E-04	4.45E-04	2.54E-02	3.19E-03	8.47E-02	5.12E-03	2.94E-02	3.85E-03
75th percentile	2.14E-03	1.87E-03	1.36E-04	1.68E-04	2.26E-04	1.28E-04	2.28E-02	2.50E-03	5.04E-02	4.55E-03	9.52E-04	1.00E-05
50th percentile	6.62E-04	7.09E-04	1.26E-04	5.94E-05	1.05E-04	7.58E-05	1.51E-02	1.11E-03	9.46E-03	3.14E-03	3.28E-04	1.00E-05
25th percentile	2 05E-04	4.26E-05	7.63E-05	1.00E-05	3.47E-05	1.00E-05	6.53E-03	1.00E-05	1.79E-03	1.57E-03	1.00E-05	1.00E-05
5th percentile	5.66E-05	1.00E-05	7.13E-05	1.00E-05	1.00E-05	1.00E-05	1.75E-03	1.00E-05	1 08E-03	6.54E-04	1.00E-05	1.00E-05

FIGURE 6-3
COMPARISON OF DUST LOADING ON SURFACES TO MEASURED RAM DUST LEVELS IN AIR

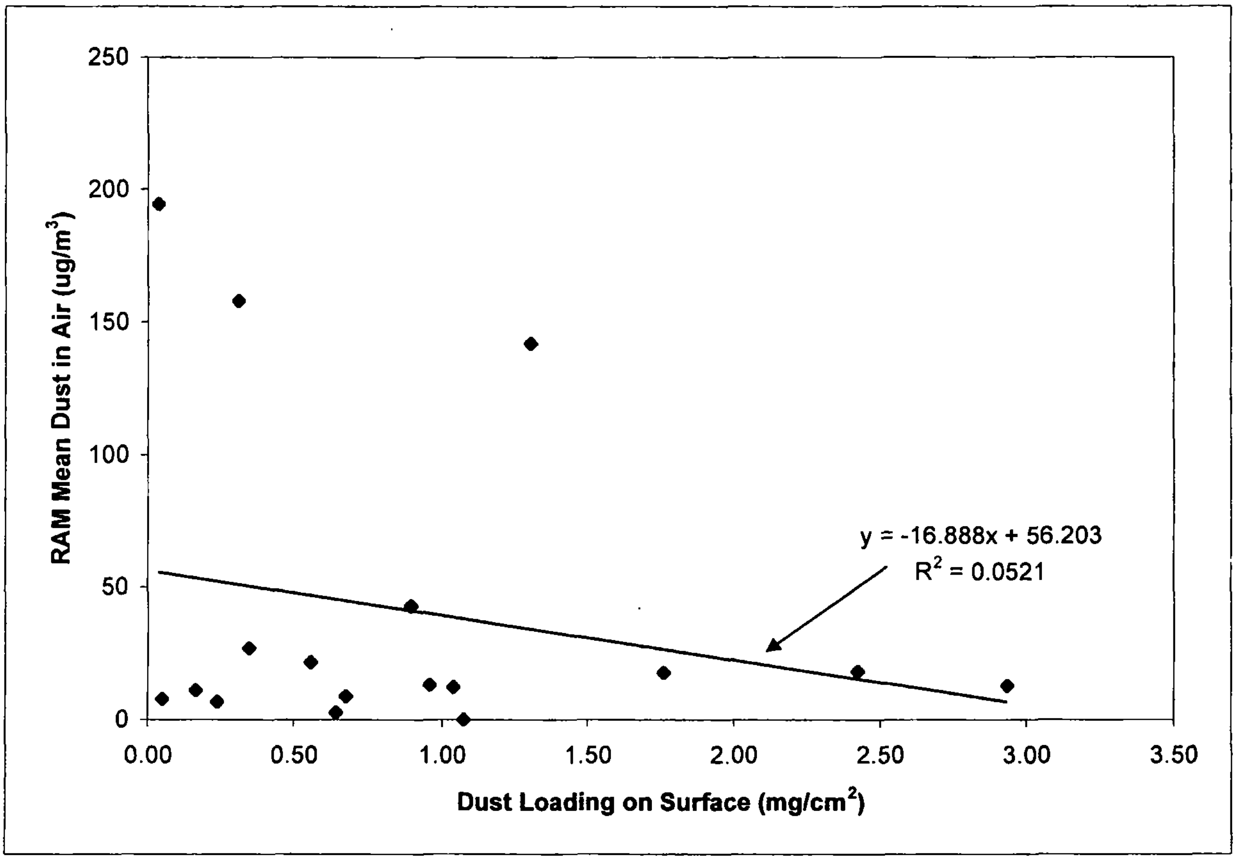


FIGURE 7-1
COMPARISON OF RAM DUST LEVELS AT UPWIND AND DOWNWIND LOCATIONS DURING OUTDOOR ABS ACTIVITIES

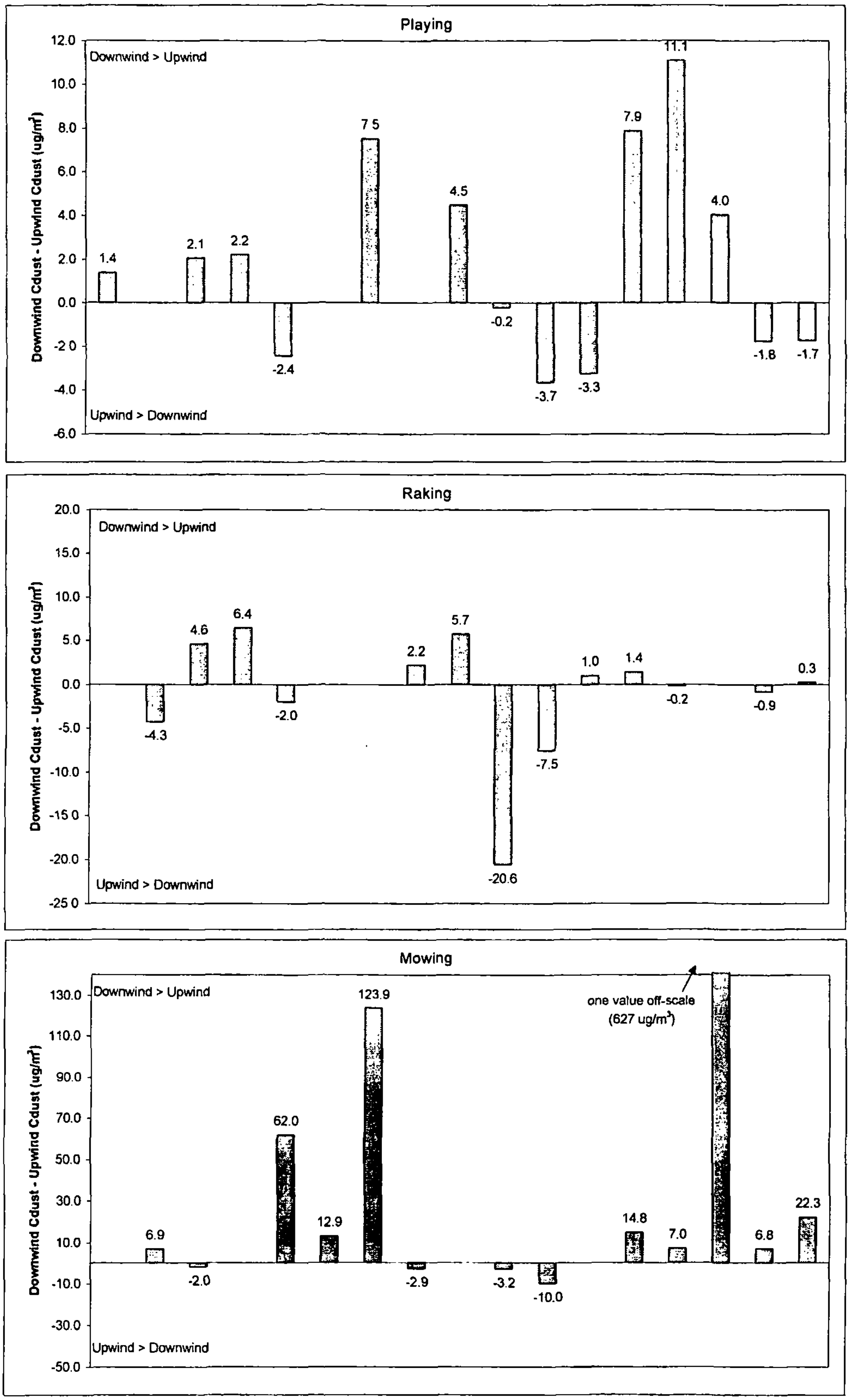
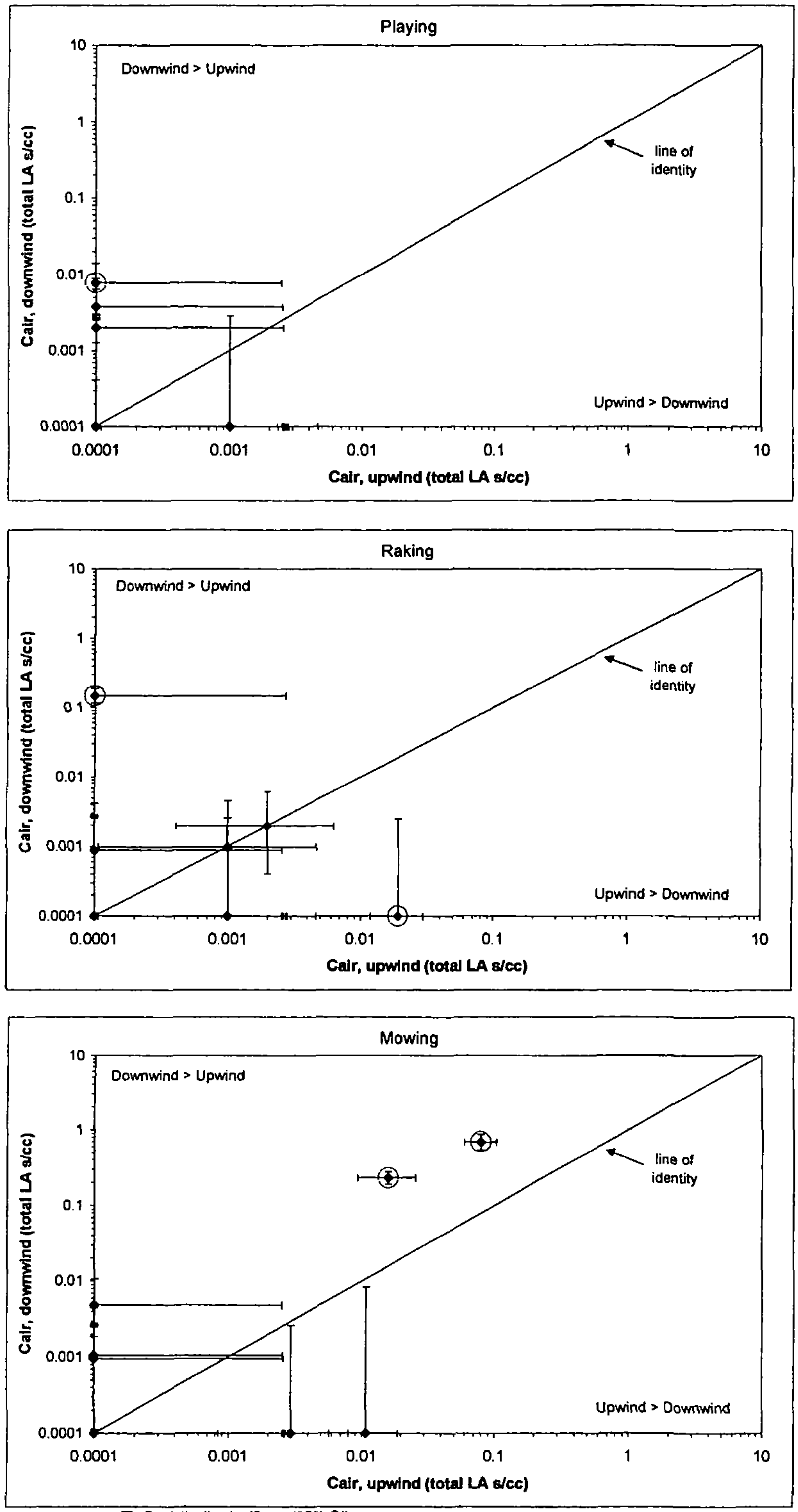
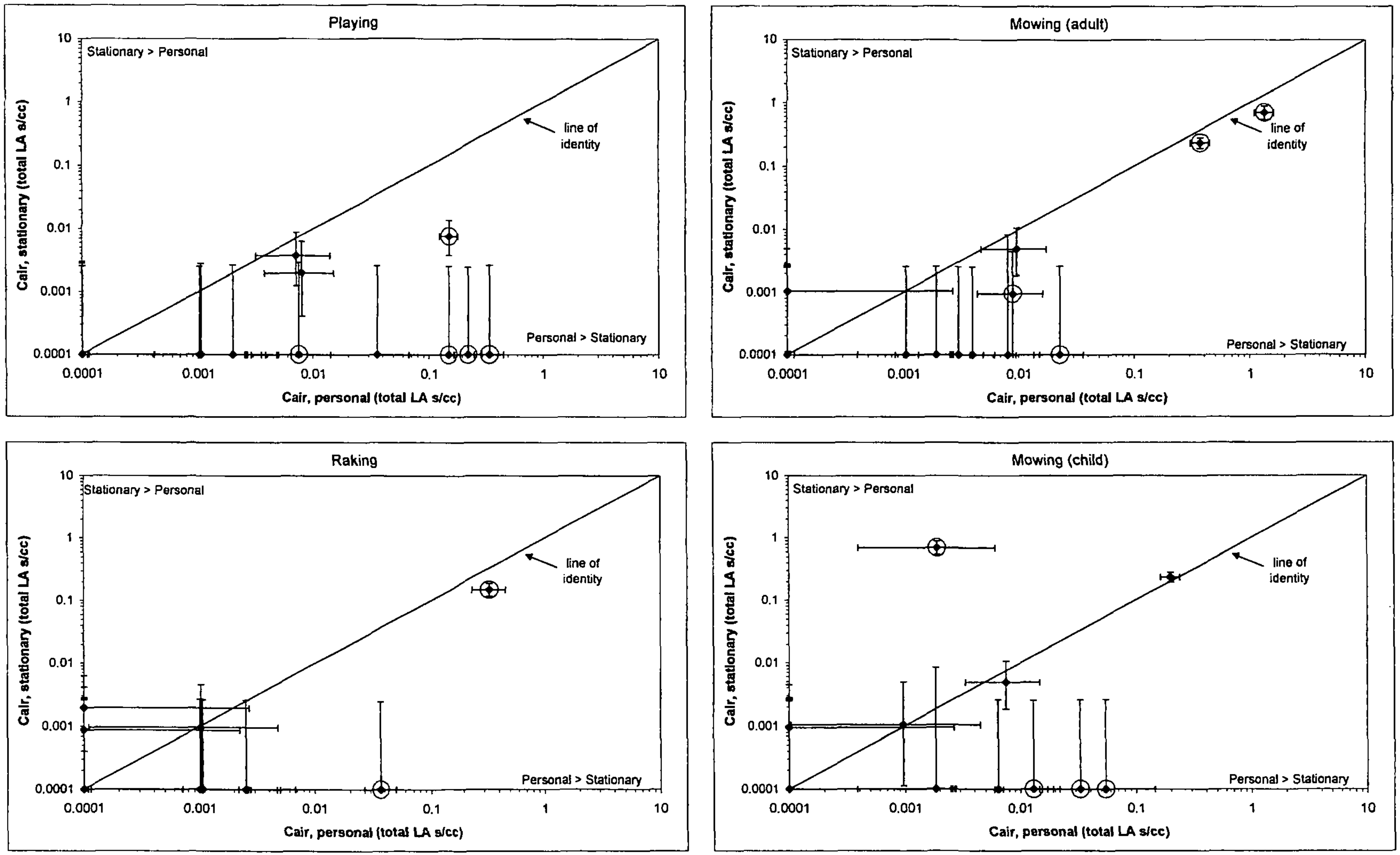


FIGURE 7-2
COMPARISON OF TOTAL LA AIR CONCENTRATIONS AT UPWIND AND DOWNWIND STATIONARY MONITORS DURING OUTDOOR ABS ACTIVITIES



Statistically significant (95% CI)
Non-detects are displayed at 0.0001 s/cc.
Error bars represent the 95% Poisson Confidence Interval

FIGURE 7-3
COMPARISON OF TOTAL LA AIR CONCENTRATIONS AT PERSONAL AND STATIONARY (DOWNWIND) MONITORS DURING OUTDOOR ABS ACTIVITIES

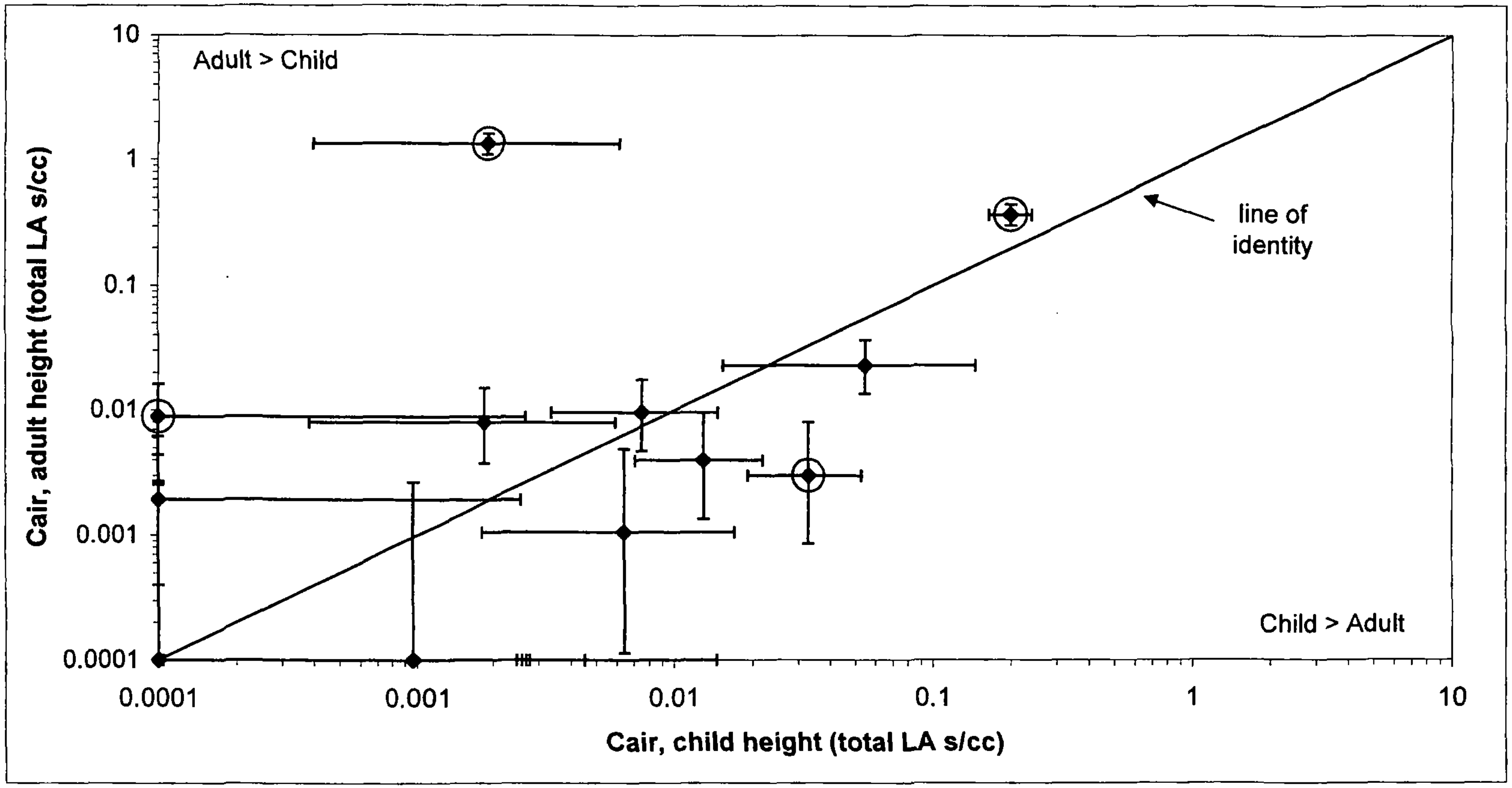


◯ Statistically significant (95% CI)

Non-detects are displayed at 0.0001 s/cc.

Error bars represent the 95% Poisson Confidence Interval.

FIGURE 7-4
COMPARISON OF TOTAL LA AIR CONCENTRATIONS AT CHILD AND ADULT HEIGHTS DURING MOWING ACTIVITIES



Statistically significant (95% CI)
Non-detects are displayed at 0.0001 s/cc.
Error bars represent the 95% Poisson Confidence Interval.

FIGURE 7-5
COMPARISON OF MEASURED RAM DUST LEVELS TO TOTAL LA CONCENTRATIONS IN AIR

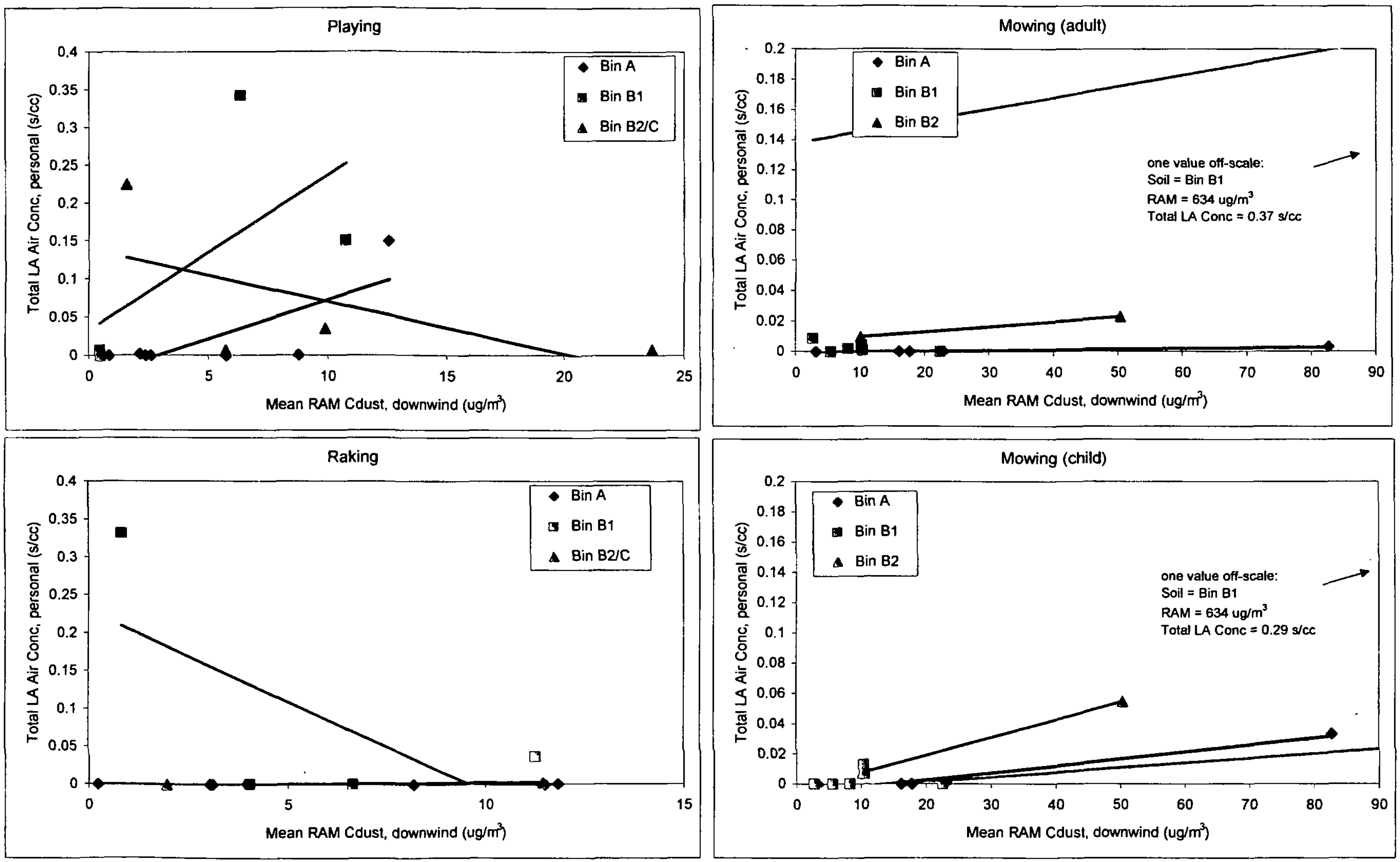
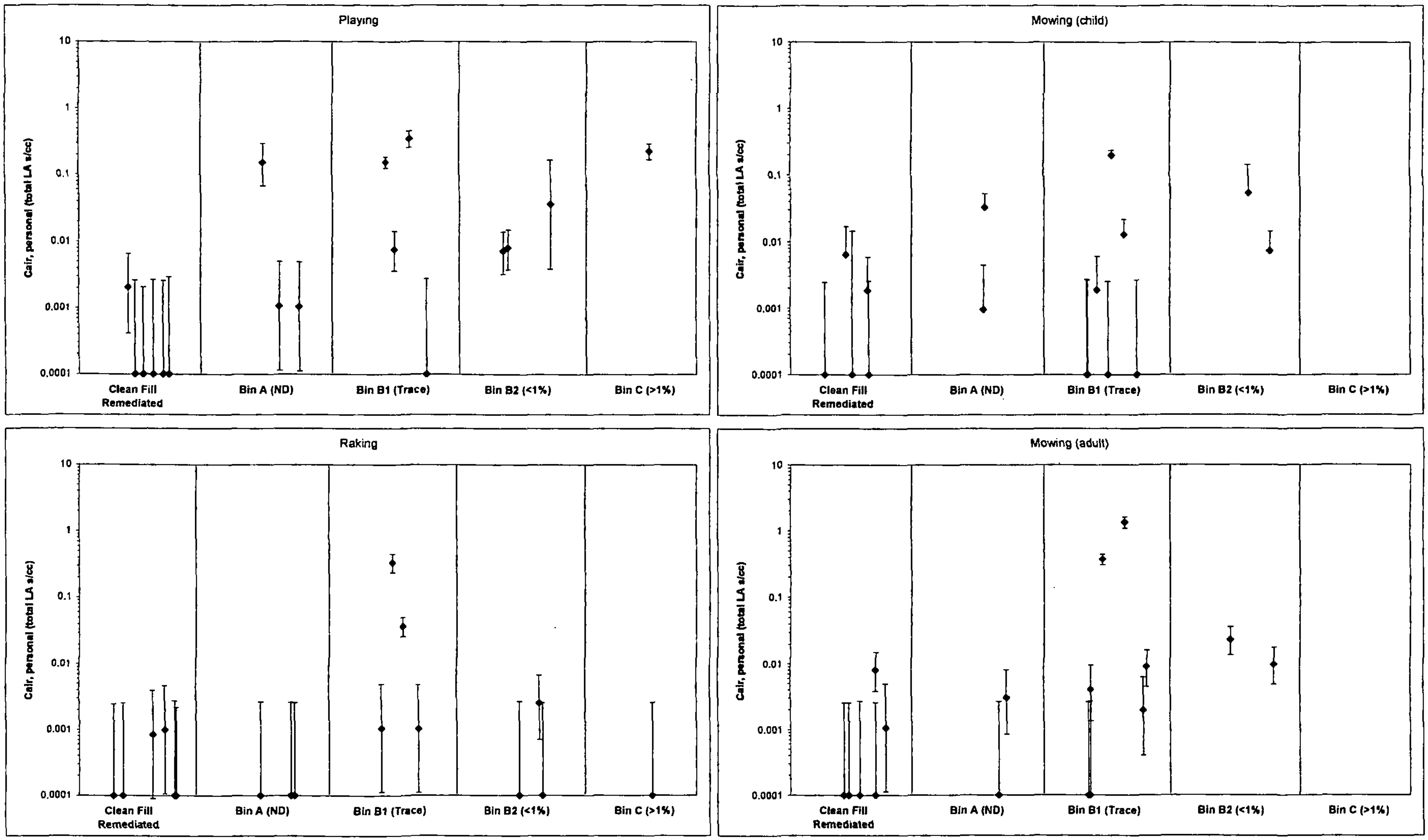
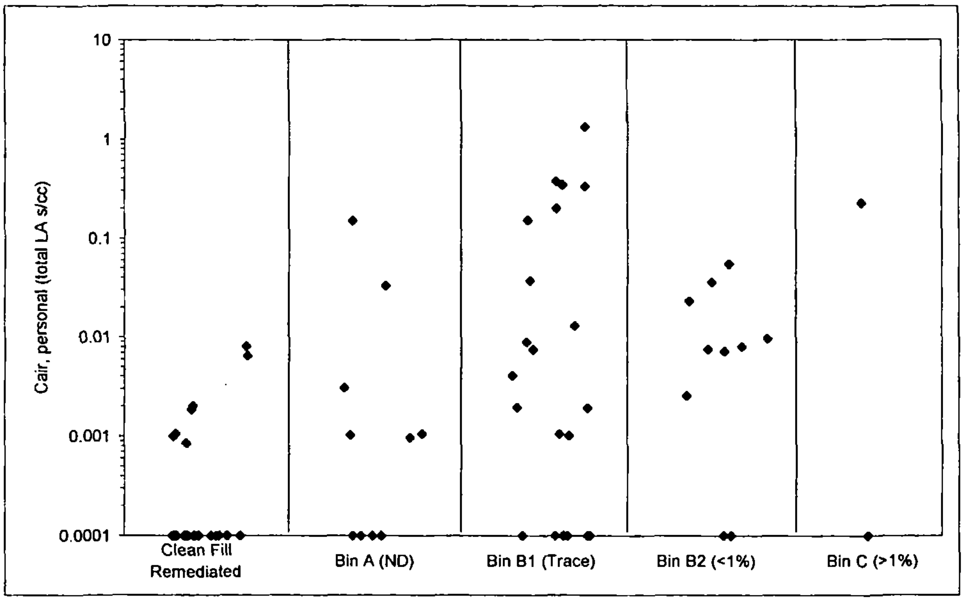


FIGURE 7-6
COMPARISON OF LA LEVELS IN SOIL AND PERSONAL AIR SAMPLES BY OUTDOOR ABS SCENARIO

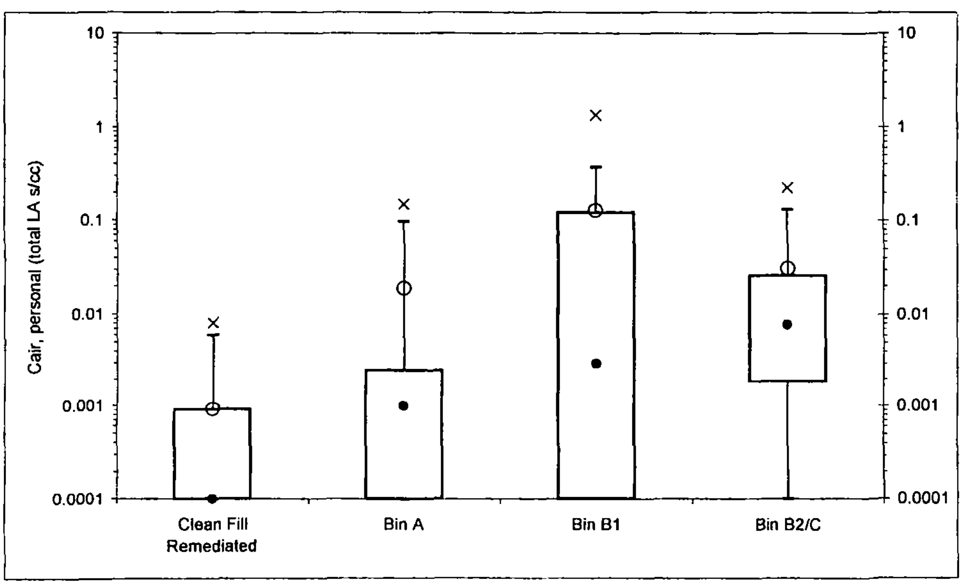


Non-detects are displayed at 0.0001 s/cc.
Error bars represent the 95% Poisson Confidence Interval.

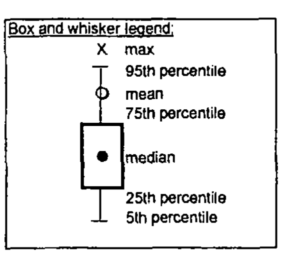
FIGURE 7-7
COMPARISON OF LA LEVELS IN SOIL AND PERSONAL AIR SAMPLES
ACROSS ALL OUTDOOR ABS SCENARIOS



Non-detects are displayed at 0.0001 s/cc.



Non-detects are displayed at 0.0001 s/cc.



	Clean Fill (Remed)	Bin A	Bin B1	Bin B2/C
N samples	23	10	22	12
max	0.0081	0.15	1.3	0.23
mean	0.00092	0.019	0.13	0.031
95th percentile	0.0060	0.097	0.37	0.13
75th percentile	0.00093	0.0025	0.12	0.026
50th percentile	0	0.0010	0.0030	0.0077
25th percentile	0	0	0	0.0019
5th percentile	0	0	0	0

Figure 9-1 Comparison of SEM and TEM Results

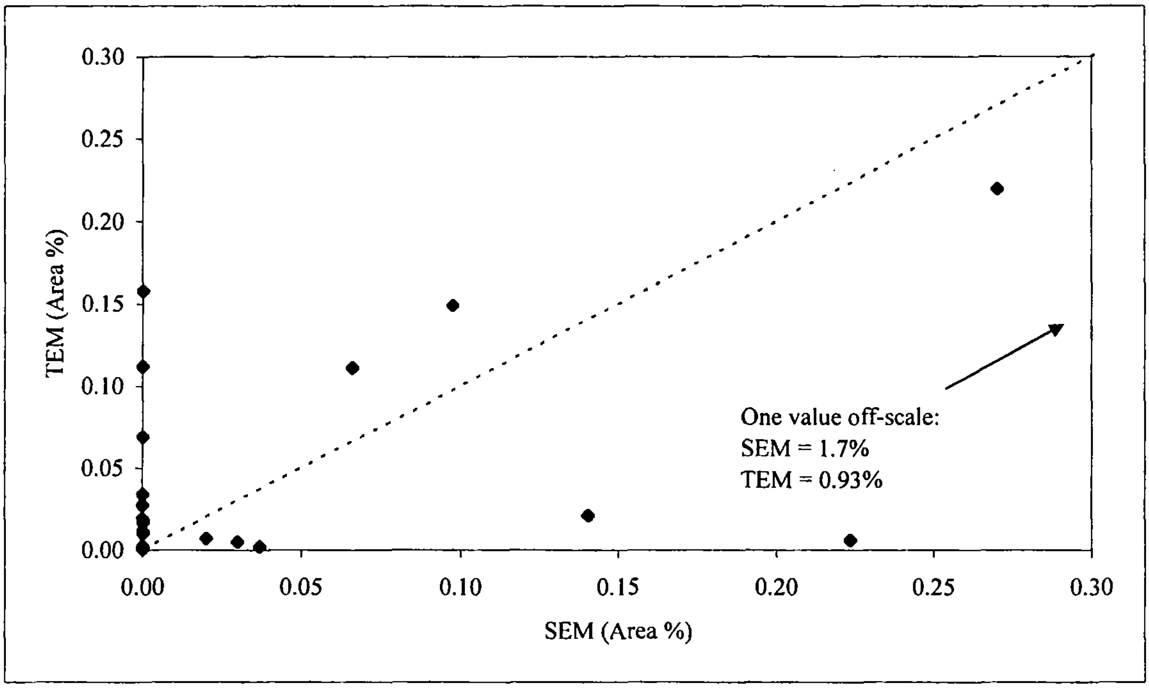
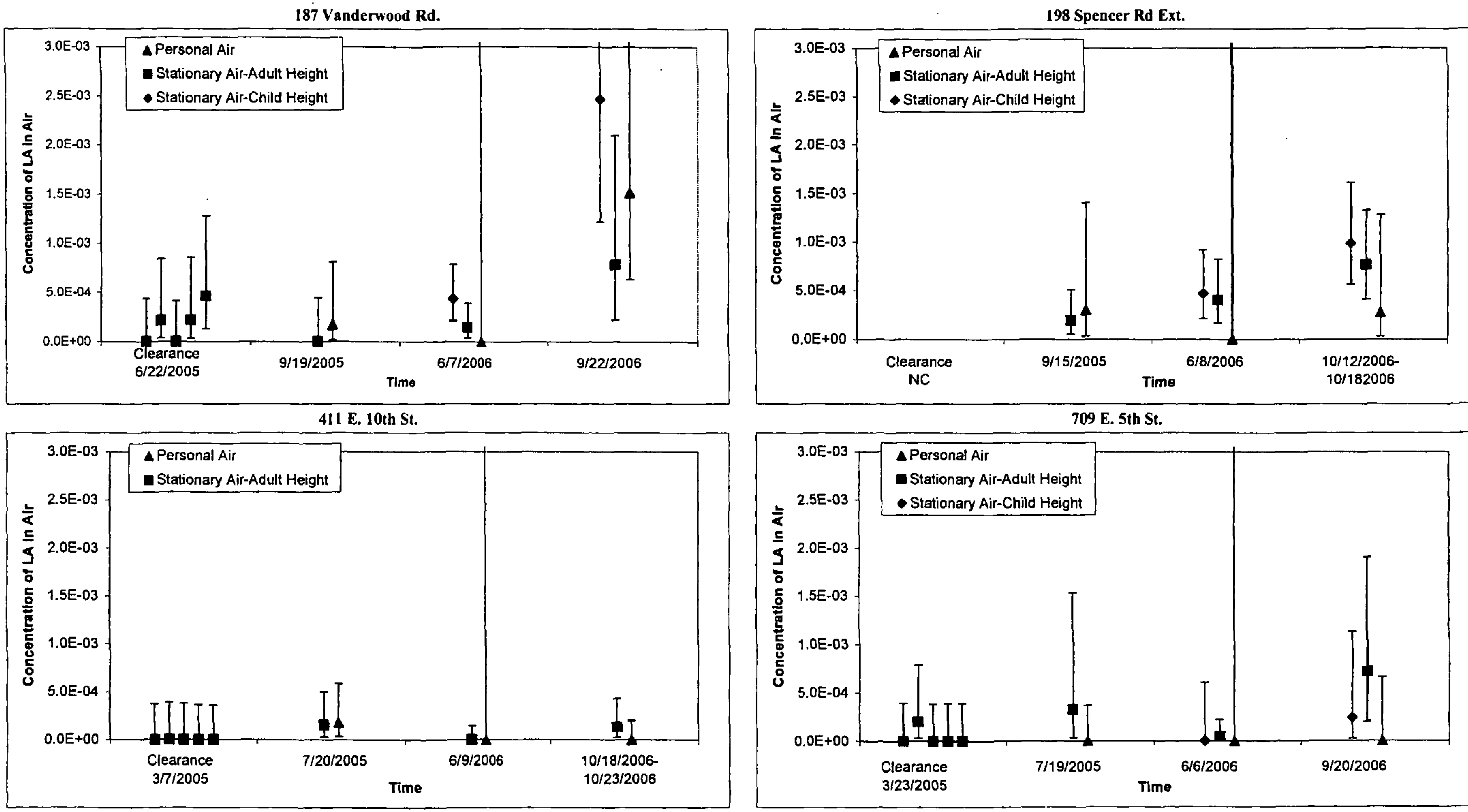
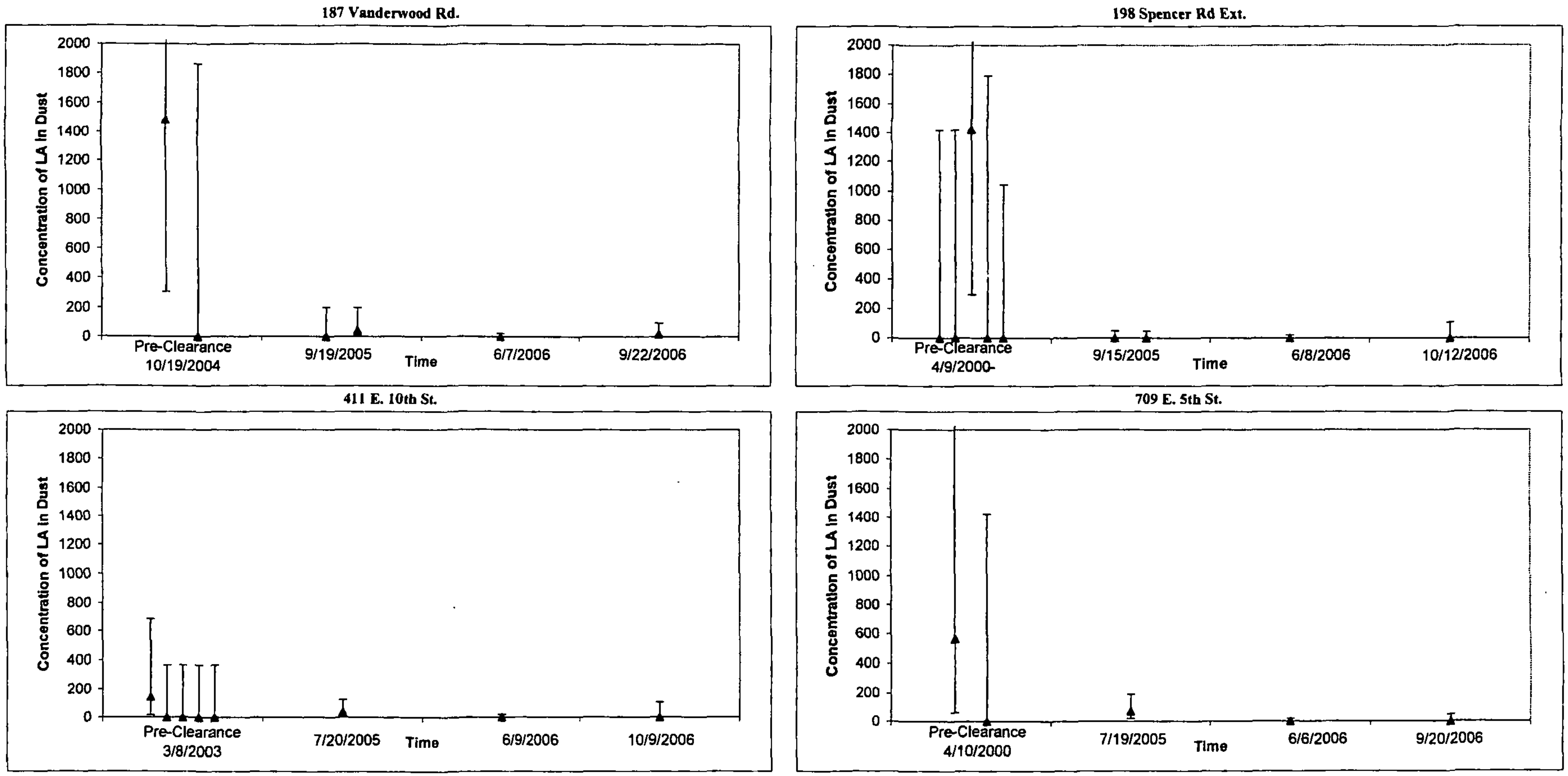


FIGURE 10-1. Time Trends in LA Air Concentrations



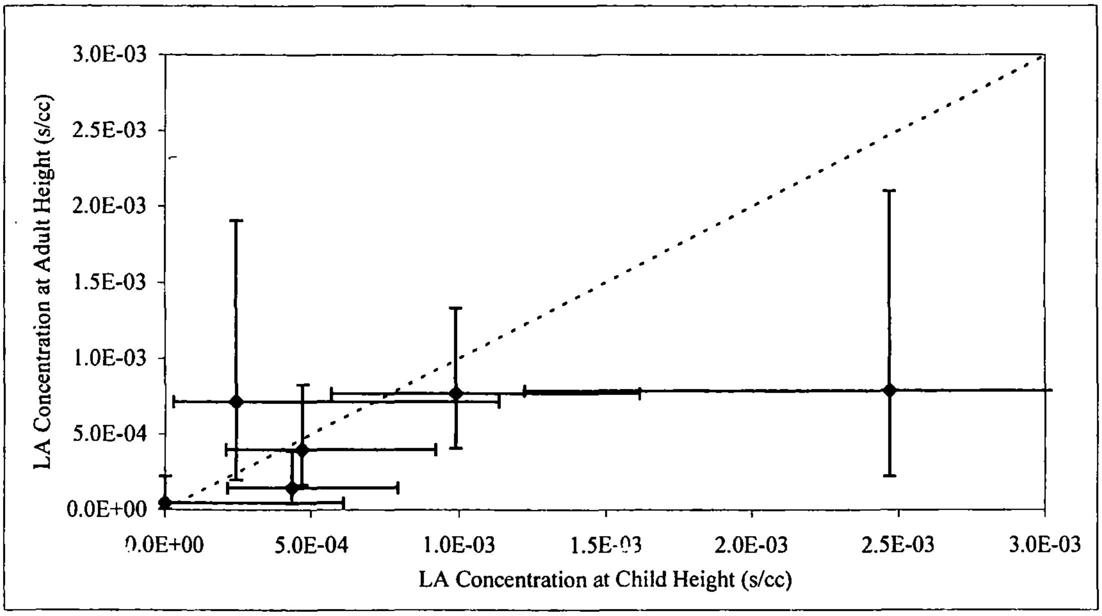
Error bars represent the 95% Poisson Confidence Interval.

FIGURE 10-2. Time Trends in LA Dust Concentrations



Error bars represent the 95% Poisson Confidence Interval.

Figure 10-3. LA Concentration Measured at Adult and Child Height



None of the paired adult and child results are statistically signicantly different based on 95% CI.
Error bars represent the 95% Poisson Confidence Interval.

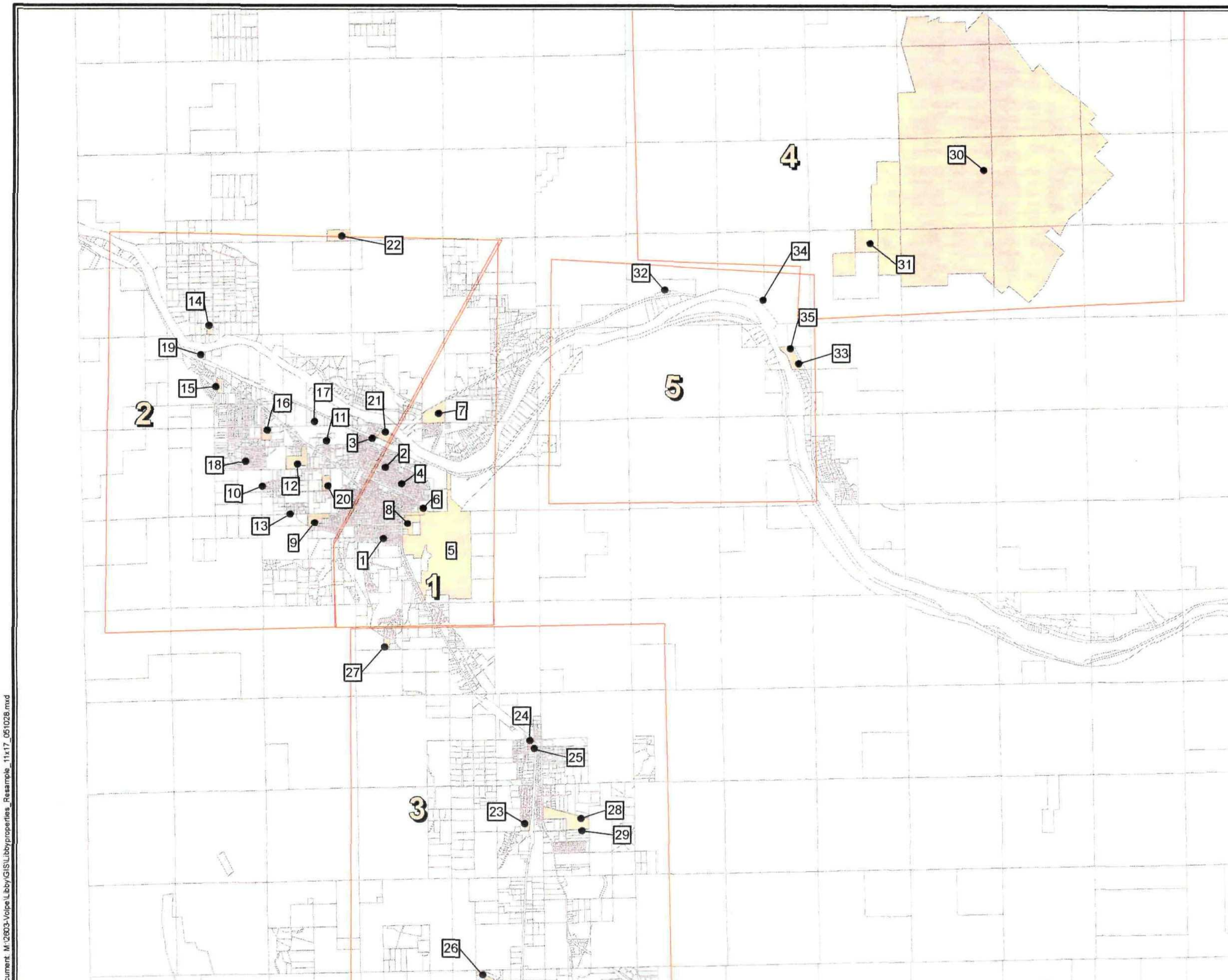


Figure 13-1
Ambient Air
Sampling Locations Stratified by Zone

See Map Legend (attached as page 2) for description of the unique locations IDs.

N
W
E
S

NOT TO SCALE

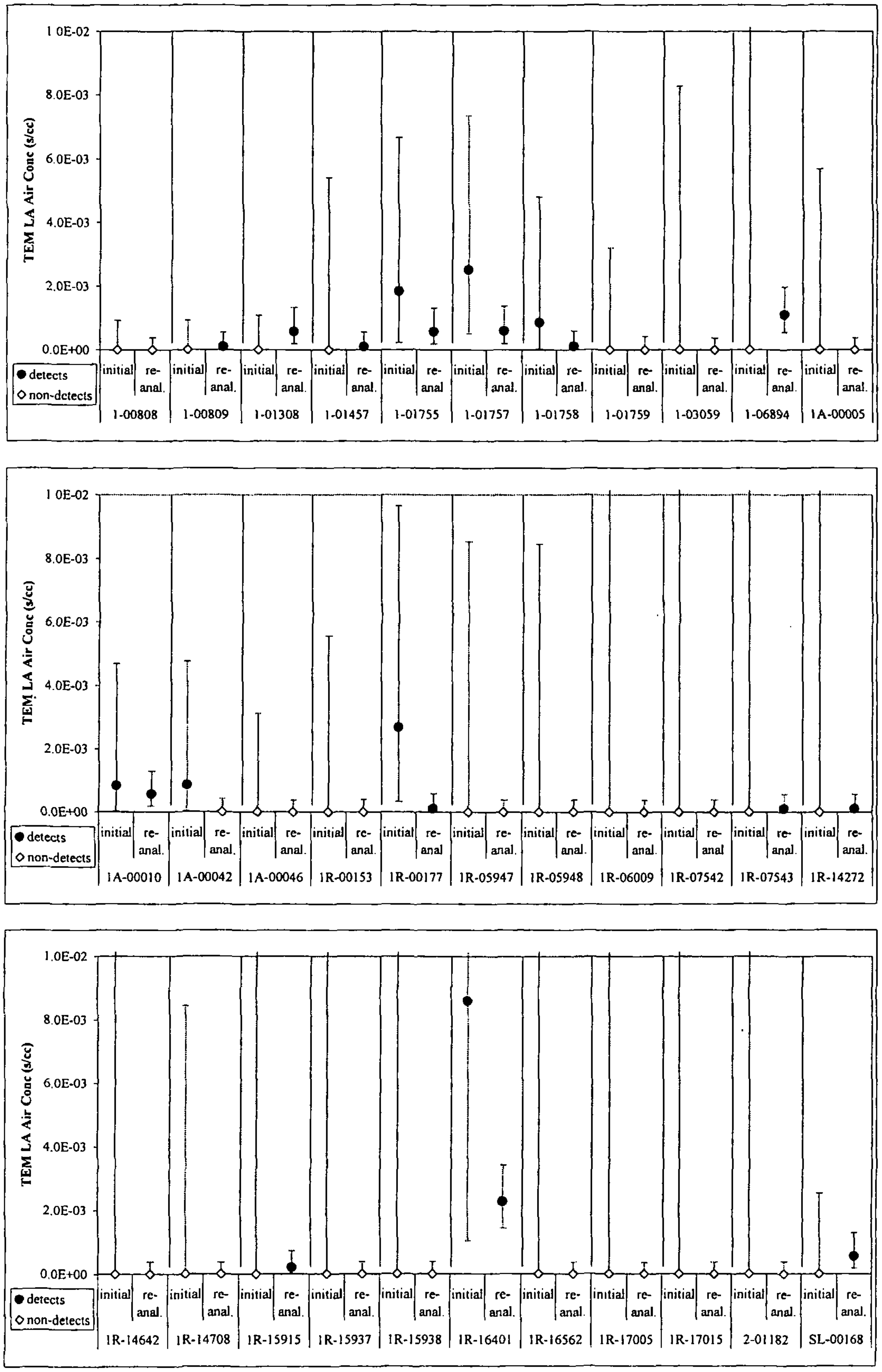
CDM

Document: M:\2603-Volpe\Libby\GIS\Libbyproperties_Resample_11x17_051028.mxd

Figure 13-1. Map Legend

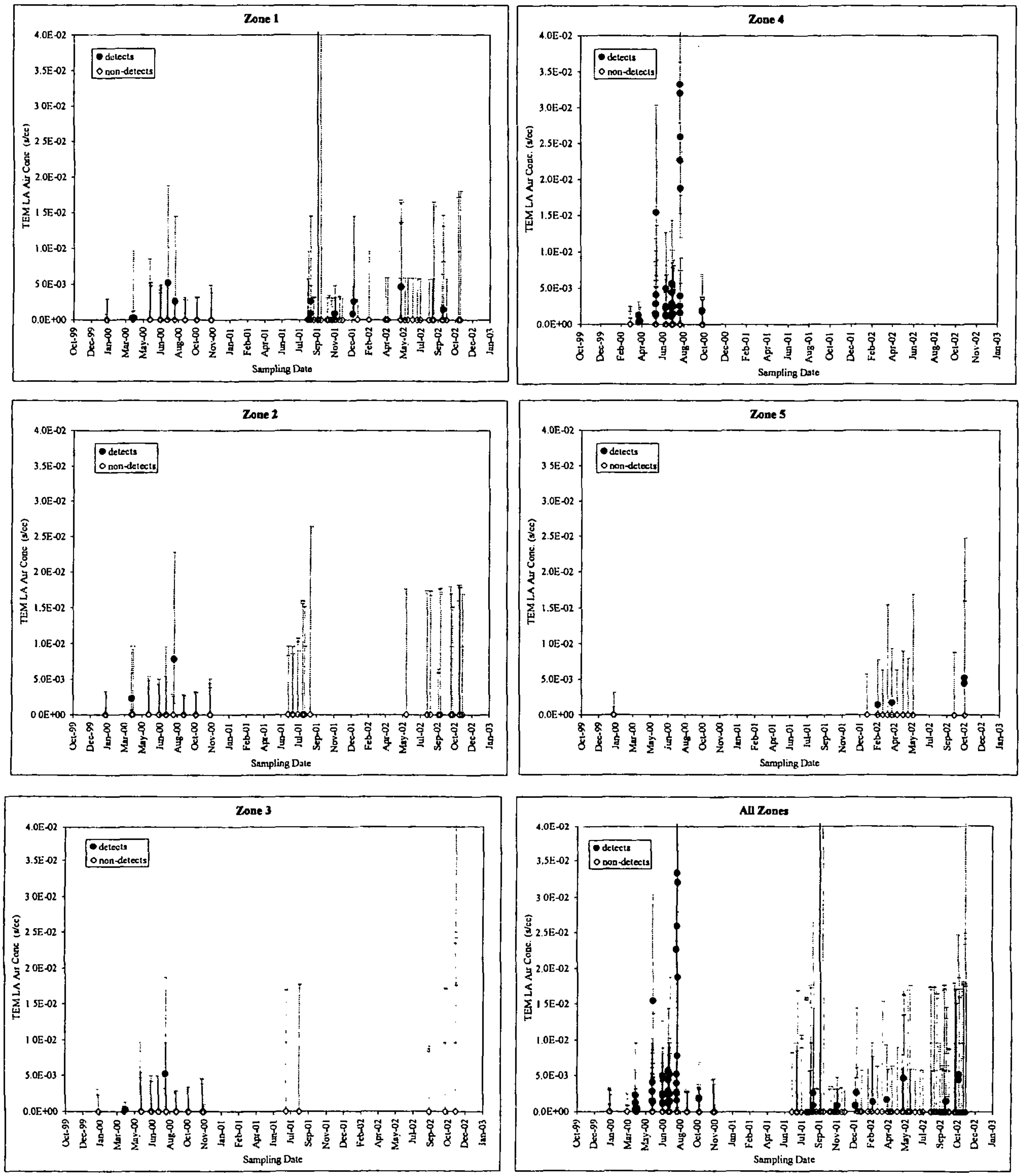
Zone	Map Identifier	Location Description	Number of Samples 2000	2001	2002
1	1	1417 Louisiana Ave			4
	2	418 Mineral Ave - County Annex Building		30	15
	3	510 W. 1st St			8
	4	605 Utah Ave			4
	5	875 Highway 2 S - Stimson Lumber			10
	6	952 E. Spruce St - Fitness Center	27		
	7	Champion Haul Rd			4
	8	MillWork West	6		
2	9	101 Ski Rd - Libby Middle School		12	
	10	110 Montgomery Dr			1
	11	123 Hamann Ave			4
	12	150 Education Way - Libby High School		12	
	13	154 Ski Rd			4
	14	156 S. Central Rd			4
	15	2113 Highway 2 W			4
	16	247 Indian Head Rd - Plummer Elementary School	27	4	4
	17	2608 W. 2nd St Ext			4
	18	319 Norman Ave			4
	19	500 Jay Effar Rd			4
	20	Armory		1	
	21	Export Plant	3		
	22	Lincoln County Landfill		4	4
3	23	34 Bowker St #13			4
	24	3496 Highway 2 S		6	
	25	3504 Highway 2 S			8
	26	781 Terrace View Rd			4
	27	819 Cabinet Heights Rd		4	
	28	899 Farm to Market Rd - McGrade Elementary	16		
	29	Jerry Dean Park, McGrade School	11		
4	30	Mine	96		
	31	Rainy Creek Rd	23		
5	32	4241 Highway 37 N			4
	33	KDC Flyway			5
	34	Rainy Creek Bank			6
	35	Screening Plant & Flyway	3		6
		Total:	212	73	119

FIGURE 13-2. COMPARISON OF INTIAL AND RE-ANALYSIS RESULTS



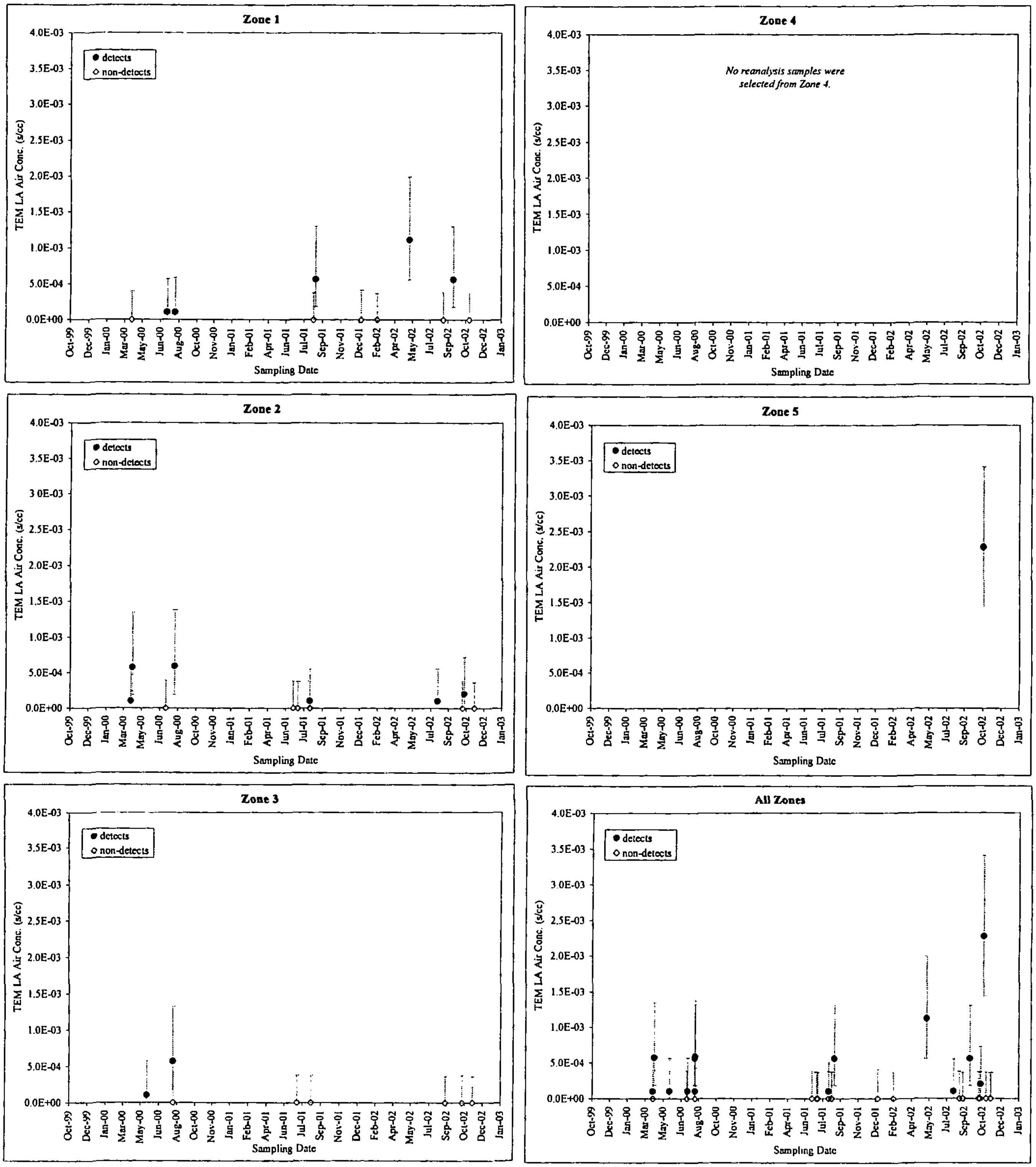
Error bars represent the 95% Poisson confidence interval

FIGURE 13-3
CONCENTRATION OF LA IN 404 AMBIENT AIR SAMPLES FROM LIBBY
INITIAL ANALYSES



Error bars represent the 95% Poisson confidence interval.

FIGURE 13-4
CONCENTRATION OF LA IN 33 AMBIENT AIR SAMPLES FROM LIBBY
RE-ANALYSIS AT IMPROVED SENSITIVITY



Error bars represent the 95% Poisson confidence interval.

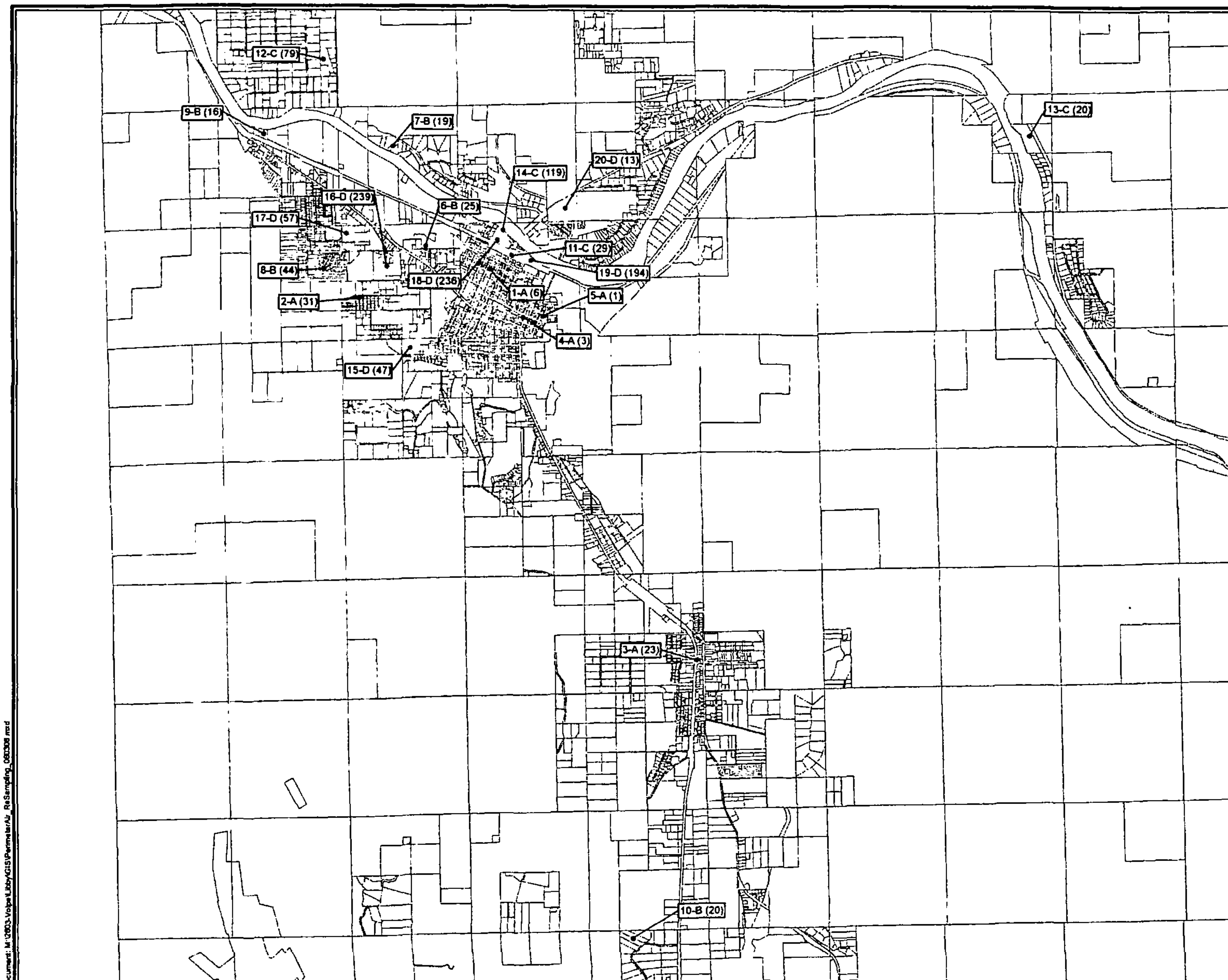


Figure 14-1
Perimeter Air Sampling Locations
Selected for Re-Analysis

Map Label	Property Address
1-A (6)	312 Main Ave
2-A (31)	341 Parmenter Dr
3-A (23)	3647 Highway 2 S
4-A (3)	507 E. Lincoln Blvd
5-A (1)	610 Michigan Ave
6-B (25)	123 Hamann Ave
7-B (19)	1573 Kootenai River Rd
8-B (44)	319 Norman Ave
9-B (16)	500 Jay Effar Rd
10-B (20)	781 Terrace View Rd
11-C (29)	102 Mineral Ave - Second Hand Store
12-C (79)	2293 Kootenai River Rd
13-C (20)	KDC Flyway
14-C (119)	Riverside Park
15-D (47)	101 Sid Rd - Libby Middle School
16-D (239)	150 Education Way - Libby High School
17-D (57)	247 Indian Head Rd - Plummer Elementary School
18-D (236)	303 W. Thomas St - former Export Plant
19-D (194)	BNSF Libby Railyard
20-D (13)	Champion Haul Rd

Map Label=Random ID-Group (N Perimeter Samples)

Group A: Low LA Soil Level (< 1%), Small Removal Size (< 1000 cy)
Group B: High LA Soil Level (≥ 1%), Small Removal Size (< 1000 cy)
Group C: Low LA Soil Level (< 1%), Large Removal Size (≥ 1000 cy)
Group D: High LA Soil Level (≥ 1%), Large Removal Size (≥ 1000 cy)

N
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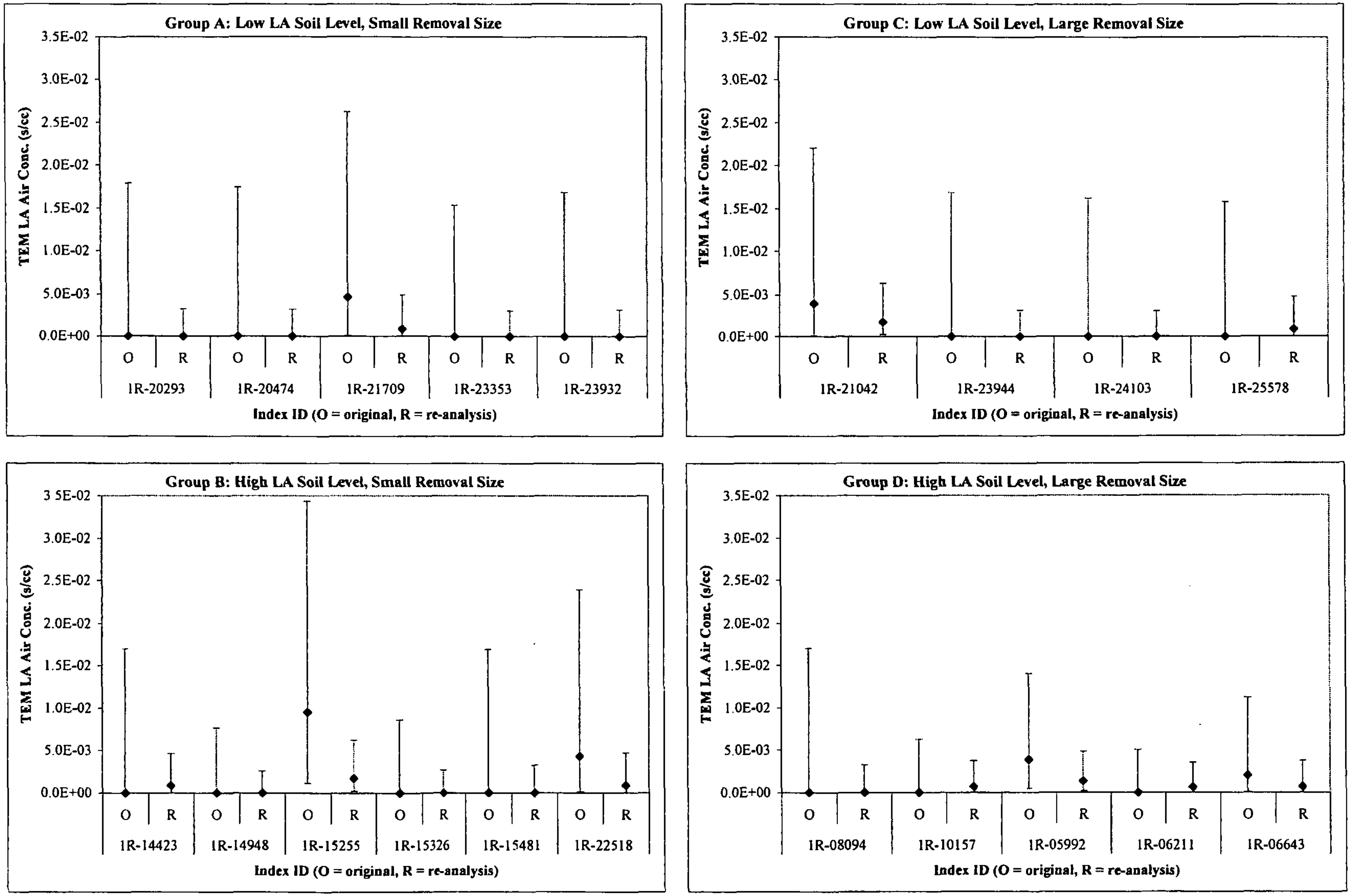
NOT TO SCALE

CDM

FIGURE 14-2
TEM RESULTS FOR PERIMETER AIR SAMPLES THAT WERE RE-ANALYZED



Error bars represent the 95% Poisson confidence interval.

APPENDICES

APPENDICES
(provided electronically on the attached CD)

2.1	Microsoft Access Database of Libby2DB
2.2	Summary of Database Corrections
3.1	Guidelines for Data Reduction for TEM Results for Libby Amphibole in Air and Dust Samples at the Libby Superfund Site [*hard copy of text provided*]
4.1	TEM Analytical Results for Field Blanks
4.2	TEM Analytical Results for Lab Blanks
5.1	Task 1: Analytical Results for Yard Soil, SUA Soil, and Dust
5.2	Task 1: Monte Carlo Simulation for Dust to Soil [*hard copy of text provided*]
5.3	Task 1: Ksd Calculation by Property
5.4	Task 1: Ksd Reality Check by Property
6.1	Task 2: TEM Analytical Results for Air and Dust
7.1	Task 3B: Analytical Results for Air by TEM and Soil by PLM-VE
7.2	Task 3C: PLM Analytical Results for Golf Course Soil
10.1	Tasks 6-9: Applicable Libby Field Modifications [*hard copy of text provided*]
12.1	Task 11: TEM Analytical Results for Air Clearance Samples
13.1	Task 12A: Selection of Ambient Air Samples [*hard copy of text provided*]
13.2	Task 12A: TEM Analytical Results for 404 Ambient Air Samples
13.3	Task 12A: TEM Analytical Results for 33 Reanalyzed Ambient Air Samples
14.1	Task 12B: Selection of Perimeter Air Samples [*hard copy of text provided*]
14.2	Task 12B: TEM Analytical Results for 8,510 Perimeter Air Samples
14.3	Task 12B: TEM Analytical Results for 1,221 Perimeter Air Samples from 20 Selected Properties
14.4	Task 12b: TEM Analytical Results for Perimeter Air Samples From 20 Properties Selected For Re-Analysis

APPENDIX 3.1

GUIDELINES FOR DATA REDUCTION FOR TEM RESULTS FOR LIBBY AMPHIBOLE IN AIR AND DUST SAMPLES AT THE LIBBY SUPERFUND SITE

1.0 INTRODUCTION

The USEPA has derived standard methods for utilizing measurements of environmental contaminants in order to estimate exposure and risk to human receptors (USEPA 1989, 1992, 2002, 2004). However, this existing guidance was developed mainly for use with chemical contaminants that are measured using traditional "wet chemistry" methods. At the Libby Superfund Site, the contaminant of chief concern is a form of asbestos referred to as Libby Amphibole (LA), and asbestos is measured using microscopic rather than chemical techniques. Because of this, there are several aspects of the procedure for computing exposure point concentrations of LA values that differ from the approaches used for other chemicals.

This document reviews these asbestos-specific issues associated with the derivation of concentration estimates for LA for use in exposure and risk calculations, and identifies the recommended strategy for data reduction at the Libby Superfund Site.

Note that the methods and conclusions presented in this document should not necessarily be assumed to apply to other forms of asbestos or to data from other sites.

2.0 BASIC EQUATIONS

When samples of air or dust are analyzed for asbestos using microscopic techniques such as transmission electron microscopy (TEM), the results are expressed in terms of the number of asbestos structures observed (N) divided by the total amount of sample examined (e.g., cc of air for air samples, cm^2 of surface for dust samples).

C(air) (s/cc) = N / Volume of air (cc)
C(dust)[1] (s/cm^2) = N / Area of surface (cm^2)

For convenience, analytical sensitivity (S) is defined the inverse of volume or area examined:

[1] Measures of the amount of LA in dust (s/cm^2) are more accurately thought of as loading rather than concentration, but for convenience, dust values are referred to as concentration in this document.

S(air) = 1 / Volume of air (cc)
S(dust) = 1 / Area of surface (cm^2)

Thus, concentration (both air and dust) is usually calculated as:

$$C = N \cdot S$$

Note that sensitivity is a function only of the amount of sample examined, not of the amount of asbestos in the sample:

$$S(air)\,(cc)^{-1} = \frac{EFA}{GO \cdot Ago \cdot V}$$

$$S(air)\,(cm^2)^{-1} = \frac{EFA}{GO \cdot Ago \cdot Area}$$

where:

EFA	=	Effective filter area (mm^2)
GO	=	Number of TEM grid openings examined
Ago	=	Area of each TEM grid opening (mm^2)
V	=	Volume of air passed through the filter (cc)
Area	=	Area of surface vacuumed onto the filter (cm^2)

In principle, the sensitivity for any sample of air or dust can be reduced to any value desired simply by examining more of the sample (i.e., by counting more grid openings), and there is no inherent limit imposed by the instrument.

3.0 COMBINING RESULTS FROM MULTIPLE ANALYSES

3.1 Pooling Results for Multiple Analyses of a Single Sample (Same Analytical Method)

In the event that a single air sample has been analyzed more than one time (e.g., by initially counting 10 grid openings and subsequently counting 40 additional grid openings in order to improve the sensitivity), assuming that the same analytical method (i.e., preparation, counting rules, etc.) was used in both analyses, the results may be combined by "pooling" the total counts observed and the total volume examined, as follows:

C(air) (s/cc) = (Total structures observed) / (Total volume examined)

$$= \frac{\sum N}{\sum V} = \frac{\sum N}{\sum (1/S)}$$

The equation for pooling dust concentration (loading) values is entirely analogous, except that results are expressed in units of s/cm^2 rather than s/cc.

3.2 Combining Results Across Multiple Samples (Same Analytical Method)

In cases where multiple samples (n) have been collected from a particular medium (e.g., air or dust) at some specified exposure location, if it is assumed that the concentration of LA in that medium at that location is approximately homogeneous, and if all of the samples were evaluated using the same method (i.e., same preparation steps, counting protocols, etc.), the results may be pooled across samples as described above for multiple analyses of the same sample. For example, this approach may be appropriate for combining results for multiple samples of indoor air collected within the same room or building, since air within a room or building is often assumed to be approximately homogeneous due to mixing and circulation.

In cases where it is not appropriate to assume that the concentration in a medium is homogeneous, but may vary from sample to sample as a function of time or space, then the best estimate of the mean concentration is obtained by computing the concentration for each sample, and then averaging across all of the n samples from that location:

$$\bar{C}(air) = \frac{\sum C(i)}{n}$$

For example, this approach might be used for a series of outdoor ambient air measurements, assuming that ambient air tends to vary over time or space.

4.0 COMBINING RESULTS BETWEEN ISO 10312 AND AHERA COUNTING RULES

Over the course of the investigation at the Libby Site, two separate sets of counting rules have been employed for TEM analysis of samples of air and dust: ISO 10312 (ISO 1995) and AHERA (AHERA 1986)[2]. Thus, an issue of general importance is the degree to which results from different

[2] In most cases, only particles with an aspect ratio of 5:1 or greater were recorded, as specified in the methods. For some projects (e.g., Phase 2), counting rules were revised to require recording and counting of particles with an aspect ratio of 3:1 or greater, as discussed in Laboratory Modifications LB-00016 and LB-000031. This variation in counting rules over time is not believed to be a source of substantial uncertainty in the comparison of results across methods.

counting methods are comparable, and whether it is appropriate to combine results obtained using different counting rules. This issue applies both to individual samples that have been analyzed by more than one approach, as well as to the comparison and combination of results across different samples that have been evaluated by different methods.

The chief difference between ISO and AHERA counting rules is that some types of complex structures (e.g., disperse clusters and matrices) are counted as single particles in AHERA, while they are usually separated out into component substructures in ISO. Because of these differences between the counting rules, analyses of samples by the AHERA method may tend to yield lower concentration values than by ISO. However, there are several lines of evidence which suggest that, at the Libby Site, differences between the ISO and AHERA counting methods are likely to be minor.

Direct Comparison of Paired AHERA and ISO Analyses

As of November 6, 2006, a total of 1,869 samples of air have been analyzed by both AHERA and by ISO counting rules. Appendix A (see attached electronic Excel spreadsheet) provides the data for all of these samples. The results are summarized below:

Prep Method	Total Pairs	Results of Paired Comparison				
		Both Non-Detect	One or Both Detects	AHERA<ISO	AHERA=ISO	AHERA > ISO
Direct	1837	1334	503	23	467	13
Indirect	32	22	10	0	10	0
Either	1869	1356	513	23	477	13

As seen, most (1837 out of 1869) of the samples were direct preparations. Of these, most (1334) were non-detect (ND) by both ISO and AHERA. Of those that were detects by one or both methods, most (467 out of 503) were not statistically different. Of those that were different, there were slightly more pairs where AHERA was lower than ISO (23 out of 503) than where AHERA was higher than ISO (13 out of 503). For 32 samples with an indirect preparation, there were 10 samples with a detection by one or both methods, and 10 out of 10 of these were not statistically different. These results support the conclusion that any differences between AHERA and ISO counting rules for LA structures in air are likely to be minimal for samples from the Libby Site.

For dust, only one paired ISO/AHERA result was located. The results for this sample were not statistically different from each other. However, it is clear that one sample is not sufficient to support a meaningful comparison.

Frequency of Particles Counted Differently

As noted above, the main difference between ISO and AHERA counting rules is that, in ISO, some complex structures are broken down into their component elements, while in AHERA most complex particles are counted as a single structure. However, at the Libby Site, the frequency with which LA occurs in complex structures that would be counted differently by AHERA than by ISO (disperse clusters and matrices with more than 1 substructure) is relatively low. Results of a query performed on November 6, 2006, are provided below:

Medium	Preparation Method	Total Number of LA Particles Observed	% of ISO Particles that would be Counted Differently by AHERA	Average Number of Countable Sub-structures per Primary Particle	Magnitude of the Difference
Air	Direct	5310	9.3%	2.7	16%
	Indirect	962	6.4%	2.7	11%
Dust	Indirect	2436	5.2%	2.6	8%

As seen, only about 5%-9% of all LA structures identified in ISO analyses were of a particle type that would have been counted differently by AHERA than ISO. For this subset of complex particles, the average number of countable fibers or structures delineated by ISO was about 2.7 per complex structure. Based on this, the expected average magnitude of the difference between ISO and AHERA counts for air samples (direct preparation) is calculated as:

$$\% \text{ Difference} = 9.3\% \cdot (2.7 - 1.0) = 16\%$$

Values for indirect air samples and dust samples are similar (8%-11%)

Based on this evaluation approach, differences between AHERA and ISO results are expected to be generally small (< 20%) for both air and dust samples from the Libby Site.

Default Guideline

Based on the weight of evidence from the two lines of evidence cited above, it is concluded that differences in LA particle counts between ISO and AHERA will generally be small, both for air and dust, and that the benefit of combining the results across counting methods (decreased statistical uncertainty due to larger sample size) will generally outweigh any minor bias or error that might be introduced by combining the results. Thus, the default guideline is that results for ISO and AHERA analyses may be compared and combined without adjustment, both within and between samples. However, each data user must consider the pros and cons of this approach for their intended data use, and document such considerations and supporting rationale when evaluating the data.

5.0 COMBINING AIR RESULTS FROM DIRECT AND INDIRECT PREPARATION

Most air samples at the Libby Site are analyzed using a direct preparation, but if the sample is overloaded with particulate matter, an indirect preparation may be required. The primary issue associated with combining or comparing the results of direct and indirect analyses is that the steps used in the indirect preparation (e.g., suspension of the sample in water, usually accompanied by sonication) may cause some asbestos structures to disaggregate into smaller particles, thereby increasing the number of countable structures.

A number of studies have been performed at other locations to investigate the effect of indirect preparation on estimates of asbestos concentration. Useful reviews are provided in HEI-AR (1991) and Breysse (1991). In general, the available data indicate that the magnitude of any difference between a direct and an indirect preparation for a sample depends on the nature of the asbestos (chrysotile vs. amphibole), and the details of the indirect preparation technique, especially the duration and energy of sonication. For chrysotile, the magnitude of the increase in estimated concentration (s/cc) due to indirect preparation is usually in the range of 2-100 fold (e.g., Hwang and Wang 1983, Sahle and Laszlo 1986), but may sometimes be as large as 1000-2000-fold (e.g., Kauffer at al. 1996, Chesson and Hatfield 1990). The magnitude of the difference is often larger for short particles (e.g., length < 5 um) than for longer particles (Hwang and Wang 1983, Chatfield 1985, Kauffer et al 1996). For amphiboles, differences between direct and indirect preparation are generally much smaller (less than 10-fold) than for chrysotile (e.g., Bishop et al. 1978, Sahle and Laszlo 1996).

Direct Comparison of Paired Air Samples from the Libby Site

At the Libby Site, very few air samples are analyzed by both direct and indirect preparations. As of September 5, 2005, only 16 examples of this type existed in the Libby database. Appendix B (see attached electronic Excel spreadsheet) provides the data for these 16 samples. Of these 16 paired results, six were non-detect (ND) by both direct and indirect preparations. Although these ND-ND pairs rank as "agreement" between the direct and indirect preparation methods, it is more revealing to compare results for pairs in which one or more analysis identified one or more LA structures. Of these (a total of 10 pairs), nine of the 10 were not statistically different between direct and indirect preparations, and one of the 10 was statistically higher for the indirect preparation than the direct preparation.

Because there were so few paired results in the existing database, especially for results that are not ND-ND, a set of 31 air samples that had previously been analyzed by TEM (AHERA) using a direct preparation method were selected for reanalysis by TEM (AHERA) using an indirect preparation method to evaluate the potential effect of indirect preparation on the number and types of LA structures observed in air samples from the Libby Site. Appendix C provides the basic study design and describes how these samples were selected. Appendix D (see attached electronic Excel spreadsheet) provides the detailed results for these 31 samples, both for the original direct analysis and the indirect reanalysis.

Table 1 summarizes the total LA results for these 31 samples, and the values are shown graphically in Figure 1 (Panel A). When compared pair-wise, indirect preparation samples were statistically higher ($p < 0.05$) than the matched direct preparation samples in 14 of 31 (45%) cases (red symbols), were statistically lower in 7 of 31 (23%) cases (green symbols), and were not statistically different in 10 of 31 (32%) of the cases (black symbols). The Wilcoxon signed rank test indicates that the paired data sets (indirect *vs.* direct) are not significantly different from each other, although the difference is close to being significant ($p = 0.07$). As shown in Figure 1 (Panel B), if the comparison is restricted to LA structures longer than 5 um, the frequency and magnitude of the differences are diminished, but there are still a number of samples in which the indirect preparation is several times higher than the direct preparation.

Particle Type and Size Evaluation

Another way to investigate the effect of indirect preparation is to examine the frequency of complex particles observed in the 31 samples evaluated by both direct and indirect preparations:

Particle Type	Percent of Total	
	Direct	Indirect
Fiber	72%	67%
Bundle	8%	1%
Cluster	0.1%	0.0%
Matrix	21%	32%

As seen, these data are consistent with the hypothesis that indirect preparation tends to decrease the occurrence of bundles, but also indicate that there is an increase in the number of matrix particles, perhaps due to breakup of large matrix particles into smaller matrix particles during sonication.

Figure 2 compares the length and width distributions for LA particles observed in the 31 samples analyzed by both direct and indirect preparation. For length (upper panel), the distribution for LA structures observed in indirect preparations tends to be left-shifted from that for direct preparations, suggesting that indirect preparation may tend to cause breakage of some long LA fibers into shorter fibers. This difference is statistically significant (Wilcoxon Rank Sum test, $p < 0.001$). For width (lower panel), the distributions are generally similar to each other except at the high end, where structures observed in indirect preparations tends to be thicker than for direct preparation. Although the difference is significant (Wilcoxon Rank Sum test, $p = 0.050$), this observation is not expected and may be due to random variation, since it is not apparent how an indirect preparation can cause LA particles to become thicker.

Discussion

Based on the various lines of evidence described above, it is concluded that indirect preparations may alter the estimated concentration of LA particles in samples of air. There is a general tendency for LA concentrations to be increased by indirect preparation, although in some samples the concentrations are apparently decreased. In many cases, the differences are within a factor of 2-3, but some differences may be larger. The differences appear to be less important for long structures (> 5 um) than for total LA (where structures < 5 um in length are also presented). The basis for the differences appears to be a complex interaction of multiple factors, including disaggregation of some complex structures into fibers, breaking of some long structures into shorter structures, and dispersion of large matrix particles into many smaller matrix particles. Because of these differences, inclusion of data from indirect preparations in the computation of exposure point concentrations for air may yield results that are different (usually higher, but sometimes lower) than would be obtained if the data were from direct preparation samples only.

Default Guideline

Because most (>97%) of all air samples collected in Libby have been analyzed using the direct preparation method, and because the difference between direct and indirect samples is usually within a factor of 2-3 (especially for long fibers), any error introduced into exposure and risk evaluations by use of occasional indirect data is likely to be minimal. Based on this, the default guidance for the Libby Superfund Site is that results for direct and indirect preparations or air samples may be compared and combined without adjustment, both within and between samples. However, each data user must consider the pros and cons of this approach for their intended data use, especially when the data for a particular location are based primarily on indirect data. In this case, the uncertainty associated with reliance on indirect data and the potential direction and magnitude of bias shall be discussed as part of any evaluation.

6.0 DEALING WITH SAMPLES WITH ZERO OBSERVED STRUCTURES

If zero structures are observed (N = 0) when a sample of air or dust is analyzed, this is generally referred to as a "non-detect" result. For analytes other than asbestos, EPA suggests that, when computing the mean of a set of samples, "non-detects" (i.e., samples whose concentration is below the detection limit of the analytical instrument) be evaluated by assigning a surrogate value of ½ the detection limit (USEPA 1989). By analogy, it is sometimes supposed that "non-detects" for asbestos should be evaluated by assigning a value equal to ½ the sensitivity. However, this is <u>not correct</u>. The analytical sensitivity in microscopic analyses is not analogous to a detection limit in a wet chemistry analysis, and use of ½ the sensitivity as a surrogate for asbestos non-detects may lead to a substantial overestimate of the true mean of a group of samples.

This is demonstrated in Figure 3. As seen, in cases where the analytical sensitivity is larger than the true concentration, if an asbestos non-detect is assigned a value equal to ½ the analytical sensitivity, the estimate of the mean will be biased high, with the magnitude of the error tending to increase as the ratio of sensitivity to true concentration increases. In cases where the analytical sensitivity is less than about ½ the true concentration, the magnitude of the error introduced by assigning ½ the sensitivity to non-detects becomes negligible.

There are two reasons why a non-detect in microscopy is not analogous to a non-detect in a traditional wet chemistry analysis, and should not be evaluated by assigning a value of ½ the sensitivity:

- A non-detect by a non-microscopic technique indicates that the amount of analyte present in the fraction of the sample placed into the analytical instrument was less than the detection limit, while a non-detect by a microscopic technique indicates that the amount of asbestos present in the fraction of the sample evaluated under the microscope was truly zero. Note that this statement is not inconsistent with the recognition that the observation of zero structures in some particular set of grid openings examined does not prove that there are zero structures in other grid opening that were not examined. This topic (uncertainty in the observed number of structures observed) is discussed in Section 7 (below).

- The results of a wet chemistry method yield continuous values, while results of a microscopic result yield discrete (discontinuous) values. That is, the concentration value reported in a microscopic analysis can only occur in multiples of the analytical sensitivity S (e.g., 0S, 1S, 2S, etc.). This means that when the true concentration of a sample is lower than the sensitivity, any and all detects will yield concentrations that are higher than the true value, rather than a reliable estimate of the true value. For example, consider the case where the true concentration is 0.001 s/cc, and the sensitivity is 0.010 s/cc. If this sample were analyzed 10 times, the expected result would be that about 9 of the 10 analyses would yield a count of zero, and one of the samples would yield a count of 1, which would correspond to a concentration estimate of 0.010 s/cc (10-times the truth). Only when the occasional high values are averaged with the "non-detects" does the estimate of the mean approach the true value.

This topic (the correct statistical approach for evaluating non-detect values from discontinuous count-based measurement methods) has been reviewed by EPA previously as part of the rulemaking process for microbial contamination in drinking water (USEPA 1999). (Note: measurement of pathogens in water is closely analogous to measurement of asbestos structures in air, in that the analysis is based on visual observation and yields discrete rather than continuous results). During a public workshop held on this topic in 1998, a number of statistical experts provided information on the correct methods for computing the concentration of *Cryptosporidium* in source waters of drinking water supplies, given that some (most) of the individual samples were "non-detect" (i.e., no spores of *Cryptosporidium* were observed in the sample analyzed). The expert panel emphasized that "non-detects" for *Crytosporidium* that occur in a set of water samples from a water system must be evaluated with a value of zero when computing summary statistics on the mean level of organisms present in the water.

7.0 DEALING WITH UNCERTAINTY

All estimates of environmental concentration values are uncertain because the measured value in each sample may not be identical to the true concentration of each sample ("measurement error"), and because a random set of samples collected from an Exposure Area may not be representative of the true average in the Exposure Area ("sampling variability"). The following sections describe statistical approaches for characterizing the uncertainty in concentration values for individual samples and in the mean of multiple samples.

7.1 Uncertainty in Individual Sample Values Due to Poisson Variation

All analytical results are associated with some degree of measurement error. That is, repeat analysis of multiple independent aliquots from the same sample usually do not yield identical results. This applies equally to analysis of asbestos and traditional wet chemistry materials.

For asbestos, for a single analysis of a sample, the concentration is estimated as:

$$C = N \cdot S = N / V$$

where:

C = Concentration (f/cc)
N = Number of countable asbestos fibers observed
S = Analytical sensitivity (cc^{-1})
V = Volume of air (cc) that passed through the area of filter examined

However, because N (the number of structures observed in the area of filter examined) is a Poisson random variable, the value of C is uncertain. The probability density function (PDF) that characterizes the uncertainty around the observed concentration is given by (Box and Tiao 1992):

$$PDF(C) \sim CHISQ(2 \cdot N+1) / (2 \cdot V)$$

where:

$CHISQ(\upsilon)$ = Chi-squared distribution function with υ degrees of freedom

Because $N = C \cdot V$, the uncertainty distribution around the observed count of N may be expressed as:

$$PDF(N) \sim 0.5 \cdot CHISQ(2 \cdot N+1)$$

Figure 4 shows the uncertainty PDFs for three hypothetical samples with counts of 0, 3, or 10 structures. As seen, for a sample with a count of zero (Panel A), the uncertainty distribution includes zero (it is the most likely value), but the distribution is right skewed and extends out to include plausible values as high as 2 or even higher. As the observed count becomes larger, the uncertainty distribution becomes more nearly centered on the sample observation, and tends to become more symmetric (Panels B and C).

Note that if a single sample has been analyzed more that one time and the results are pooled (see Section 3.1), this same approach may be used to characterize the uncertainty in the pooled analysis.

At the Libby Site, each analytical measurements should be reported with a description of the statistical uncertainty around the measurement. The statistic recommended for normal reporting is the two-sided 90% CI (5^{th} percentile to the 95^{th} percentile). This interval will include the true concentration in approximately 90% of all samples, and there is 95% confidence that the true concentration is less than or equal to the upper bound. However, other confidence intervals may be presented when this is considered to be important in proper characterization and interpretation of the data.

7.2 Uncertainty in the Mean of Multiple Samples with Poisson-Only Variation

In cases where multiple samples have been collected from an exposure area and pooling is not considered to be appropriate, uncertainty in the mean concentration that is attributable to random Poisson variation in the analytical count can be characterized using Monte Carlo simulation, as follows:

Step 1. For each sample, specify the uncertainty distribution around the observed concentration as described above:

$$PDF(C_i) \sim CHISQ(2 \cdot N_i+1) / (2 \cdot V_i)$$

Step 2. Using an appropriate computer software application, draw one random value from each sample and compute the mean.

Step 3. Repeat Step 2 many times. Select the 95th percentile of the means as a conservative estimate of the true sample mean.

It is important to stress that this approach evaluates only the uncertainty arising from random Poisson variation in count, and does not include uncertainty due to variation in concentration over time and space. Thus, the UCL-based on Monte Carlo simulation will usually underestimate the combined UCL, except in special cases where there is very little spatial or temporal variability between samples.

7.3 Uncertainty in the Mean of Multiple Samples Due to Poisson Measurement Error Combined with Spatial and/or Temporal Variability

When a set of samples is collected from an exposure area in which concentration varies over space or time, the resulting data values include the between-sample variability that arises from both analytical measurement error in individual samples and from between-sample temporal or spatial variability. The mathematical procedure for computing the 95% UCL of the mean for a data set depends on the attributes of the data set. EPA has developed methods and software (ProUCL) that are suitable for use with traditional "wet chemistry" values, but ProUCL does not tend to perform well when provided with data sets similar to those observed in Libby, and alternative methods for computing the UCL of the mean for such data sets are not yet well developed. Region 8 is currently investigating methods for estimating the UCL of the mean for sample sets similar to those expected to occur in Libby, and will issue guidance on this topic after improved statistical techniques are identified.

8.0 CONCLUSIONS

At the Libby Superfund Site, available data support the following conclusions regarding the estimation of LA in samples of air or dust:

- Estimates of LA concentration in air do not differ substantially when measured using ISO 10312 and AHERA counting rules, and results may be compared and combined for data evaluation. However, each data user must consider the pros and cons of this approach for their intended data use, and document such considerations and supporting rationale when evaluating the data.

- Paired data that compare ISO and AHERA results are not available for samples of dust, but the frequency of particles in dust samples that would be counted differently by the two methods is low. Thus, it is considered likely that dust samples analyzed by ISO and AHERA will also generally be similar, and hence they may also be combined across methods. However, each data user must consider the pros and cons of this approach for their intended data use, and document such considerations and supporting rationale when evaluating the data.

- In some (but not all) samples of air, estimates of LA concentrations may be several fold higher when measured using an indirect preparation compared to a direct preparation. Thus, use of the indirect results may tend to overestimate exposure and risk estimates in some cases. Because of the low frequency of indirect preparations for air samples at the Libby Site, this is likely to be a minor source of uncertainty in most cases, but should be identified as a source of uncertainty whenever exposure point concentration values are based primarily on indirect samples.

- When computing the best estimate of the arithmetic mean concentration of asbestos for an exposure point, all non-detect values must be evaluated using a concentration of zero. This is in contrast to the approach used for most other chemicals, where ½ the detection limit is assigned to non-detects. However, the analytical sensitivity in microscopic analyses for asbestos is not analogous to a detection limit in a wet chemistry analysis, and use of ½ the sensitivity as a surrogate for asbestos non-detects may lead to a substantial overestimate of the true mean of a group of samples.

- Individual sample results should be accompanied by a characterization of the uncertainty in the values. The 2-sided 90% confidence interval is recommended for most cases. However, other confidence intervals and supporting justification for its use may be presented when it is considered to be important in proper characterization and interpretation of the data.

- Uncertainty in the mean concentration of a data set of multiple samples due to the combined effect of analytical measurement error and temporal or spatial sampling variability. At present, no statistical approach for computing the UCL of the mean of a set of asbestos measurements has been developed. Region 8 is working to develop such a method, and will issue guidance when the method is finalized.

It is important to stress that these conclusions and recommendations may not apply to other forms of asbestos or to data from other sites.

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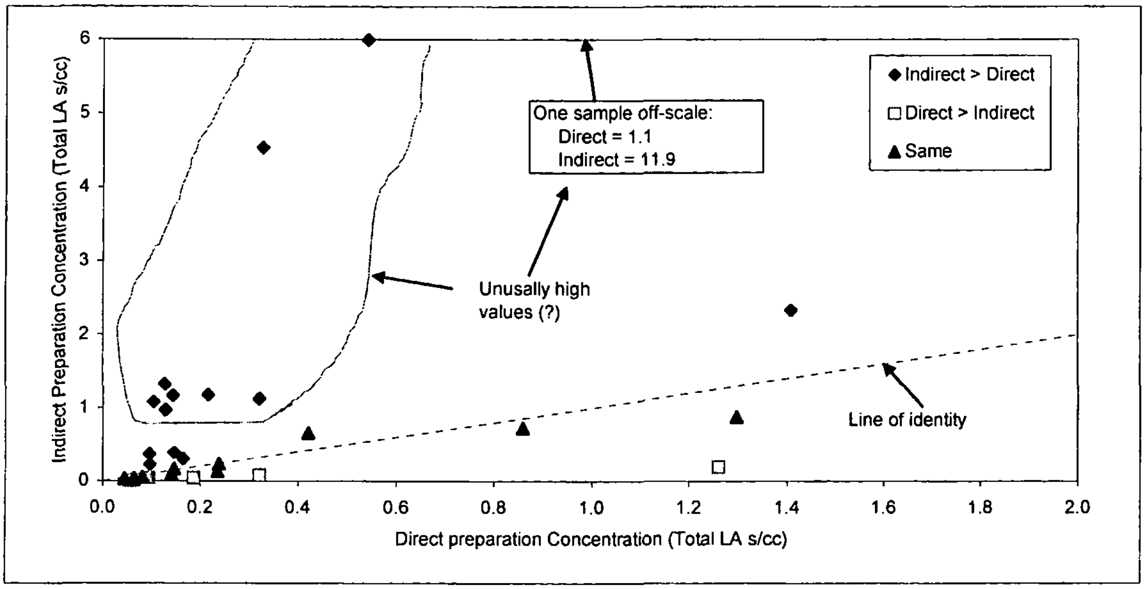
TABLE 1
SUMMARY OF 31 AIR SAMPLES ANALYZED BY DIRECT AND INDIRECT PREPARATION

Sample	Index ID	Sample Date	Property Description	Location	Land Use	Location	Type	Personal Activity Description	LA Air Conc (s/cc)		Ratio of Conc	Statistical test
									Direct	Indirect		
1	1R-04986	5/24/01	Rainy Creek Rd	Haul Rd loop	Industrial	Outdoor	Stationary		0.096	0.363	3.78	Indirect > Direct
2	1R-08838	9/5/01	KDC Bluffs	Property	Residential	Outdoor	Personal	Labor - water hose	0.097	0.221	2.28	Indirect > Direct
3	1R-14215	7/23/02	KDC Flyway	Property	Industrial	Outdoor	Personal	Laying Curlex	0.147	0.384	2.62	Indirect > Direct
4	1R-14387	8/12/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Water Hose Operator	0.143	1.164	8.13	Indirect > Direct
5	1R-14413	8/20/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.216	1.175	5.44	Indirect > Direct
6	1R-14508	8/12/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.166	0.298	1.80	Indirect > Direct
7	1R-14528	8/16/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Laborer	1.102	11.893	10.79	Indirect > Direct
8	1R-14660	8/20/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.128	1.321	10.36	Indirect > Direct
9	1R-14851	8/28/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.104	1.079	10.36	Indirect > Direct
10	1R-14909	9/5/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Laborer	0.321	1.124	3.50	Indirect > Direct
11	1R-15074	9/13/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Upper decon	0.128	0.971	7.56	Indirect > Direct
12	1R-21599	7/15/03	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Truck Driver (Water)	0.329	4.535	13.80	Indirect > Direct
13	1R-21808	7/30/03	Rainy Creek Rd	Mine	Industrial	Outdoor	Personal	Operator-upper dozer	0.543	5.994	11.04	Indirect > Direct
14	1R-29025	5/17/05	1511 Gallatin Ave	Attic	Residential	Indoor	Personal	Bulk VCI Removal	1.408	2.332	1.66	Indirect > Direct
15	1R-04987	5/24/01	Rainy Creek Rd	Adj. #19 Terrance	Industrial	Outdoor	Stationary		0.045	0.033	0.74	Not different
16	1R-05349	6/19/01	Screening Plant	Auto	Residential	Outdoor	Stationary		0.065	0.038	0.59	Not different
17	1R-05586	6/27/01	Screening Plant	Property	Residential	Outdoor	Personal	Drive - Volvo #11	0.082	0.053	0.65	Not different
18	1R-14553	8/16/02	156 S. Central Rd	House	Residential	Indoor	Personal	Vacuuming attic	0.421	0.664	1.58	Not different
19	1R-14217	7/23/02	KDC Flyway	Property	Industrial	Outdoor	Personal	Laying Curlex	0.236	0.130	0.55	Not different
20	1R-23338	10/1/03	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Upper Dozer	1.299	0.882	0.68	Not different
21	1R-07741	8/16/01	Screening Plant Flyway	Property	Mine	Outdoor	Personal	Operate - Bulldozer, upper level	0.147	0.168	1.15	Not different
22	1R-14725	8/22/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.141	0.088	0.62	Not different
23	1R-14733	8/27/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Deconning Truck	0.239	0.235	0.98	Not different
24	1R-29026	5/17/05	1511 Gallatin Ave	Attic	Residential	Indoor	Personal	Bulk VCI Removal	0.859	0.732	0.85	Not different
25	1R-14416	8/19/02	Rainy Creek Rd	Road	Industrial	Outdoor	Personal	Decon	0.187	0.044	0.24	Direct > Indirect
26	1R-14570	8/19/02	156 S. Central Rd	House	Residential	Indoor	Personal	Cleaning attic	0.094	0.044	0.47	Direct > Indirect
27	1R-21585	7/14/03	Rainy Creek Bank	Road	Residential	Indoor	Personal	Water Truck Driver	0.321	0.081	0.25	Direct > Indirect
28	1R-26146	8/13/04	Rainy Creek Rd - S Frontage	Property	Residential	Outdoor	Personal	Water Hose Operator	1.262	0.188	0.15	Direct > Indirect
29	1R-28513	1/7/05	4000 Pipe Creek Rd	Property	Commercial	Outdoor	Stationary		0.055	0.000	0.00	Direct > Indirect
30	1R-31263	6/22/05	105 W. 2nd St	Parking Lot	Residential	Outdoor	Stationary		0.056	0.004	0.08	Direct > Indirect
31	1R-31264	6/22/05	105 W. 2nd St	Parking Lot	Residential	Outdoor	Stationary		0.064	0.008	0.13	Direct > Indirect

FIGURE 1
COMPARISON OF DIRECT AND INDIRECT TEM RESULTS
FOR 31 AIR SAMPLES FROM LIBBY

Panel A: Total LA



Panel B: Length > 5 um

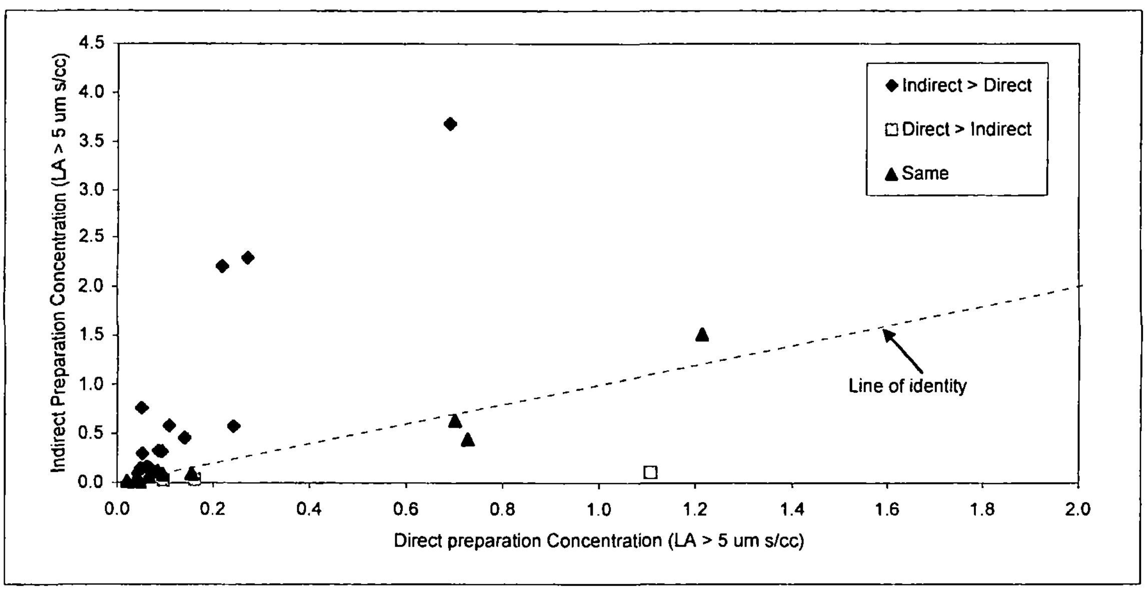
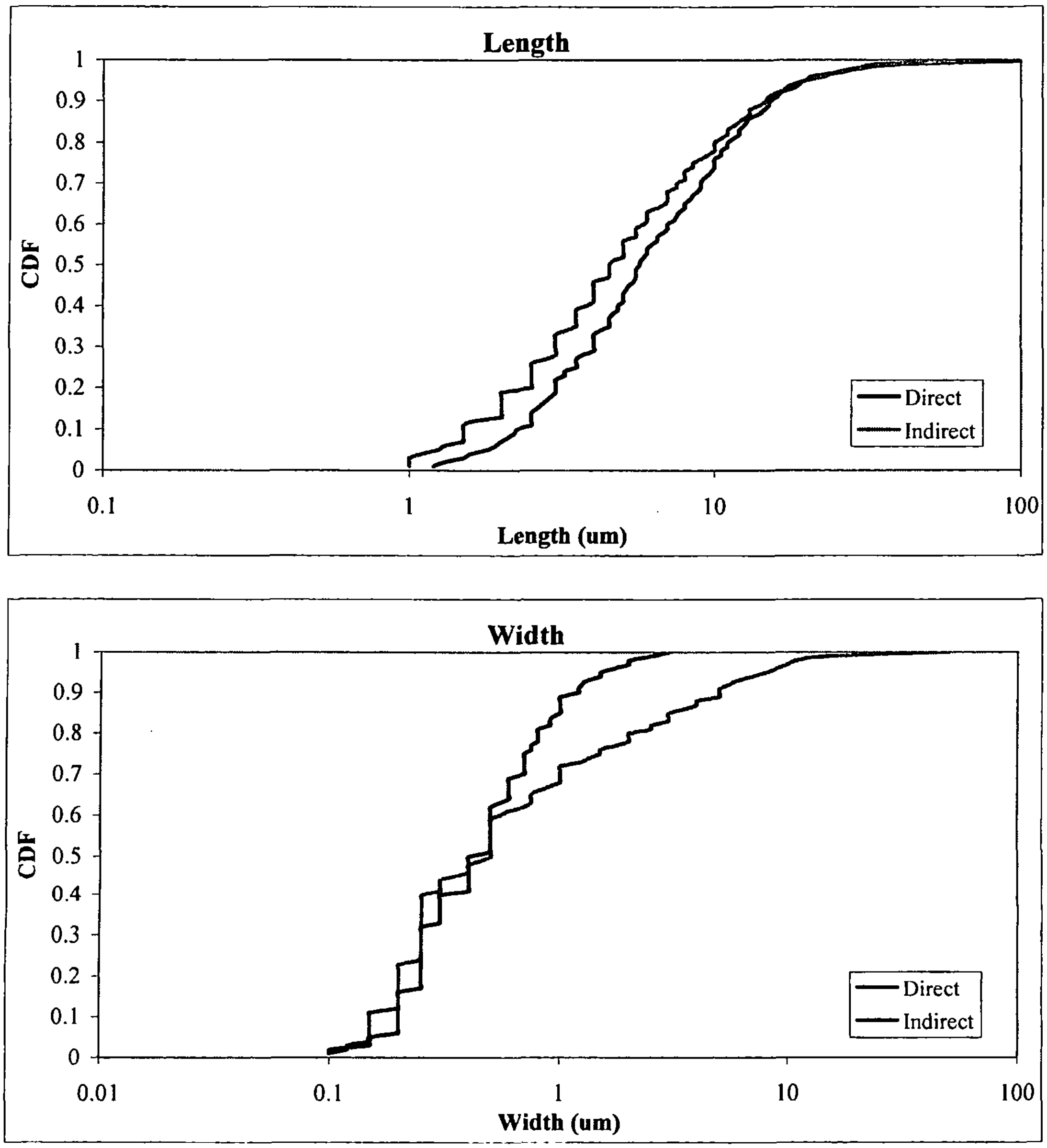


FIGURE 2
LA PARTICLE SIZE DISTRIBUTIONS FOR
31 PAIRED DIRECT AND INDIRECT PREPARATIONS



Graphs are based on paired results for the 31 samples analyzed by both direct and indirect preparation methods [N=754 structures in direct analysis, 1,617 structures by indirect analysis].

FIGURE 3
EFFECT OF ALTERNATIVE SURROGATE VALUES FOR NON-DETECTS ON THE EXPECTED SAMPLE MEAN FOR ASBESTOS

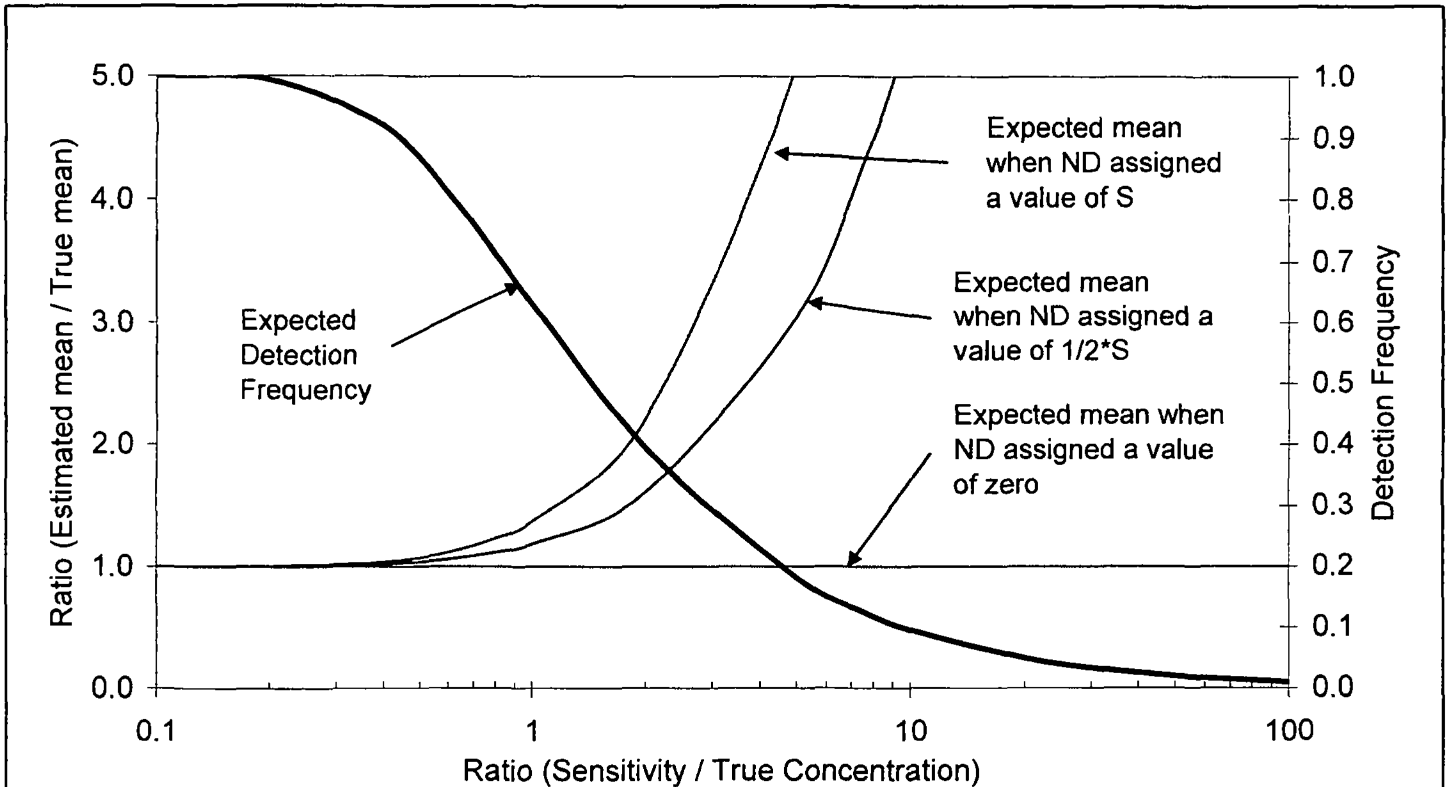
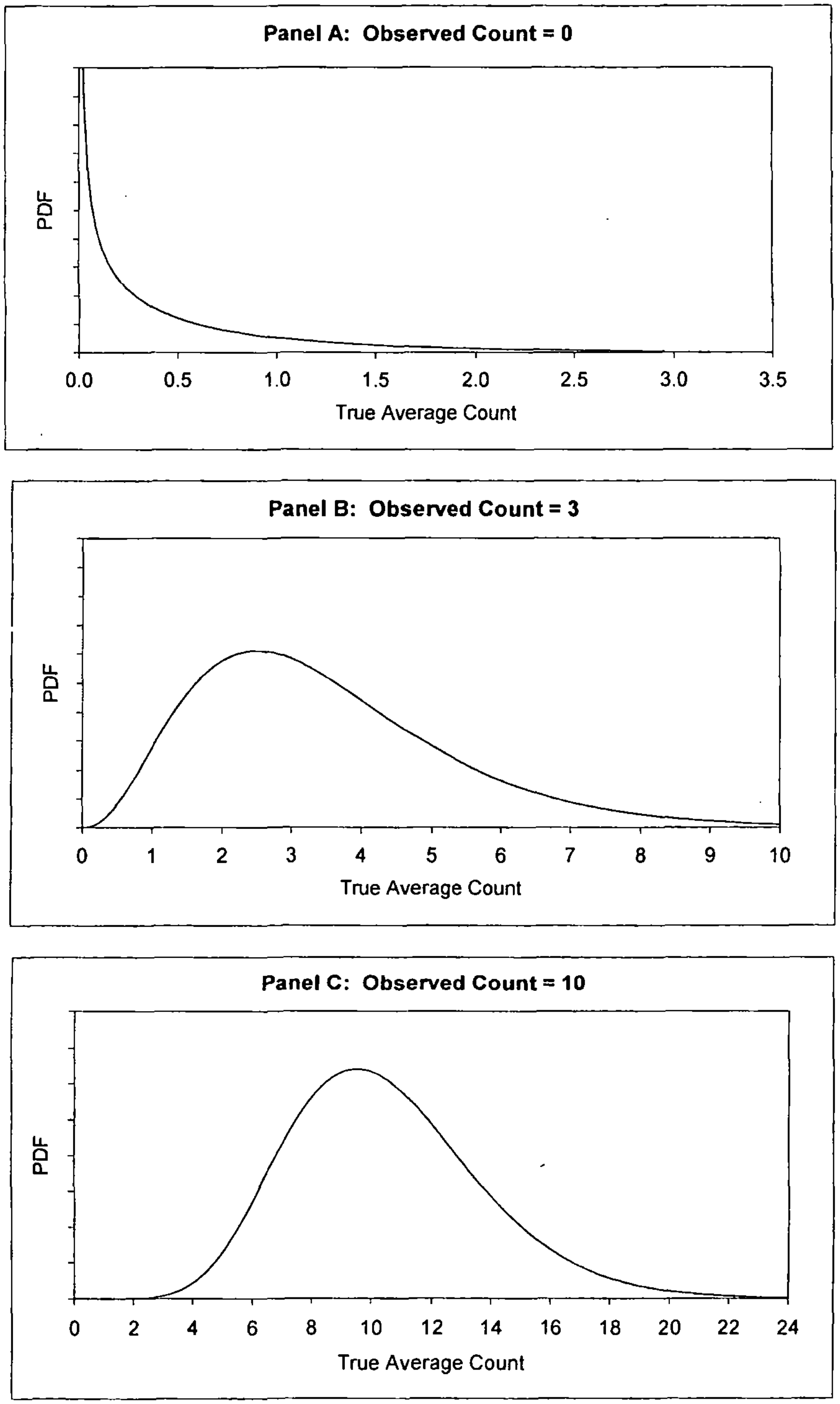


FIGURE 4. COUNTING UNCERTAINTY IN SINGLE SAMPLES



APPENDIX A

1,837 Samples Analyzed by ISO 10312 and AHERA

See Microsoft Excel Spreadsheet "AppA_AHERA vs ISO.xls"

APPENDIX B

16 Air Samples Evaluated by Direct and Indirect Analysis

See Microsoft Excel Spreadsheet “AppB_I vs D_Original 16.xls”

APPENDIX C

Study Design and Selection of 31 Air Samples for Re-Analysis Using Indirect Preparation

PILOT STUDY DESIGN

EFFECT OF INDIRECT PREPARATION ON LA STRUCTURE COUNT IN AIR SAMPLES FROM LIBBY, MT

October 5, 2005

APPROVALS:

10/6/05

Jim Christenson, USEPA, Site RPM

Peggy Churchill for Mary Goldade 10/6/05

Mary Goldade, USEPA, Regional Chemist

PILOT STUDY DESIGN

EFFECT OF INDIRECT PREPARATION ON LA STRUCTURE COUNT IN AIR SAMPLES FROM LIBBY, MT

1.0 INTRODUCTION

At the Libby, Montana, Superfund site, most samples of air analyzed for Libby amphibole (LA) by transmission electron microscopy (TEM) are evaluated using a direct preparation method. However, some air samples contain sufficient levels of dust and other debris that an indirect preparation is needed to reduce the total loading on the filter for TEM examination. One potential limitation to an indirect preparation is that suspending the sample in water may cause some asbestos structures to disaggregate into smaller structures, thereby influencing the total number and types of asbestos structures observed. The purpose of this pilot study is to investigate whether indirect preparation does or does not result in a significant change in the number of LA structures counted under TEM.

2.0 PILOT STUDY DESIGN

Sample Selection

The pilot study will be performed on a set of 35 air samples from Libby. These samples were selected from the set of all air samples already collected at the site and which have already been analyzed by TEM-AHERA using a direct preparation method. Samples analyzed originally by TEM-AHERA were selected because any disaggregation of complex structures that may be caused by the indirect preparation is more likely to be observable using AHERA counting rules than ISO 10312 counting rules. Because the purpose of this pilot study is to compare air concentrations between the two preparation methods, the selected air samples were restricted to air samples in which LA has been detected (as determined based on the direct preparation results). Because the uncertainty in air concentration is directly related to the total number of structures observed (i.e., as N increases, the relative uncertainty decreases), samples with more than 10 LA structures observed in 10 or fewer grid openings were selected preferentially. Because the indirect preparation requires ½ of the original filter (see below), only samples that have ½ or more of the original filter available for re-analysis were considered. The amount of filter remaining was estimated from the database by assuming that ¼ of the filter was used for each type of analysis performed. For example, for a sample that had been analyzed by PCM and by TEM-AHERA, it was assumed that ½ of the filter would remain.

A total of 77 samples were identified which met the selection criteria above. These are listed in Table 1. Of these 77 samples, 35 samples were selected for re-analysis using indirect preparation. These 35 were selected at random, seeking to include samples from a variety of different locations around the site. Table 2 identifies the 35 air samples that were selected. If for any reason one or more of these samples can not be located or is otherwise considered unsuitable for use, any other sample from Table 1 may be substituted.

Sample Preparation

For each sample identified for indirect preparation, the original sample filter will be obtained from archive storage. If more than ½ of the original sample filter is available, ½ of the primary filter will be used in the indirect preparation, and the remaining fraction of original filter will be saved for future reference. If only ½ of the original filter is available, all of the filter will be used in the preparation[1]. The portion of the primary filter will be suspended in about 50 mL of filtered deionized (FDI) water in a graduated cylinder. In order to ensure that any structures that may have come off the filter during transport of storage are recovered, the inside of the cassette (filter removed) will then be rinsed with about 25-50 additional mL of FDI water, which will be added to the graduated cylinder. The entire volume of water (75-100 mL) will be applied to the secondary filter, which will be equal in diameter to the primary filter (typically 25 mm). This procedure will result in an F-factor of 0.5.

Counting and Stopping Rules

All indirect preparations will be prepared for TEM examination as usual. Samples will be counted using the same AHERA counting rules as were used during the original analysis. That is, all LA structures that are at least 0.5 um long and have an aspect ratio of 5:1 or greater will be recorded. The number of grid openings analyzed in the indirect analysis will be twice the number analyzed in the original (direct) analysis (see Table 2).

Data Recording

Data will be recorded in the most recent version of the TEM spreadsheet for analysis of air and dust samples. The sample comment field on the TEM spreadsheet should identify that the sample was evaluated as part of the indirect preparation pilot study (e.g., "Indirect Pilot Study").

3.0 DATA EVALUATION

The LA air concentration from the indirect preparation will be compared to the LA air concentration from the direct preparation for the same sample. The comparison will be based on an evaluation of the ratio of the concentrations (indirect *vs* direct), as well as the method for comparison of two Poisson rates described by Nelson (1982). In addition, the frequency of occurrence of each type of structure classification (fiber, bundle, cluster, matrix) will be compared between the two types of preparation methods for the same sample. These results are expected to allow a determination as to the effect of indirect preparation on LA asbestos particles.

[1] While EPA prefers to always retain a fraction of the original filter for re-analysis if needed, the goals of this study were considered to be sufficiently important that sacrificing the remaining filter for a selected subset of all samples was considered acceptable.

TABLE 1 LIST OF CANDIDATE SAMPLES

Index	ISO Analyses Performed	AHERA Analyses Performed	PCM Analyses Performed	Portion of Filter Remaining (a)	selected for pilot study	Property Description	Indoor/ Outdoor	Personal/ Stationary	Index ID	Media	Analysis Method	Prep Method	Analysis Date	GO Size (mm2)	GO Counted	EFA (mm2)	F-Factor	Air Volume (L)	Analytic Sensitivity (s/cc)	Lab Name	Lab Job Number	Lab Sample ID	Total N LA Struc	LA Loading (s/mm2)	LA Air Conc (s/cc)
1		X		0.75	1	105 W. 2nd St	Outdoor	Stationary	1R-31264	Air	TEM-AHERA	DIRECT	23-Jun-05	0.013	5	385	1	1474	0.00401837	Mobile Lab	270500592	270500592-0002	16	246.1538462	0.064293915
2		X		0.75	1	105 W. 2nd St	Outdoor	Stationary	1R-31263	Air	TEM-AHERA	DIRECT	23-Jun-05	0.013	5	385	1	1376	0.004304562	Mobile Lab	270500592	270500592-0001	13	200	0.055959302
3		X	X	0.5	1	1511 Gallatin Ave	Indoor	Personal	1R-29026	Air	TEM-AHERA	DIRECT	24-May-05	0.013	10	385	1	131	0.022607164	Mobile Lab	270500410	270500410-0002	38	292.3076923	0.859072225
4		X	X	0.5	1	1511 Gallatin Ave	Indoor	Personal	1R-29025	Air	TEM-AHERA	DIRECT	24-May-05	0.013	10	385	1	61	0.048549811	Mobile Lab	270500410	270500410-0001	29	223.0769231	1.407944515
5		X	X	0.5	1	156 S. Central Rd	Indoor	Personal	1R-14574	Air	TEM-AHERA	DIRECT	21-Aug-02	0.0129	10	385	1	423	0.007055546	Mobile Lab	270200224	270200224-0001	23	178.2945736	0.162277567
6		X	X	0.5	1	156 S. Central Rd	Indoor	Personal	1R-14553	Air	TEM-AHERA	DIRECT	17-Aug-02	0.0129	10	385	1	149	0.020030175	Mobile Lab	270200212	270200212-0009	21	162.7906977	0.420633682
7		X	X	0.5	1	156 S. Central Rd	Indoor	Personal	1R-14570	Air	TEM-AHERA	DIRECT	20-Aug-02	0.0129	10	385	1	665	0.004487964	Mobile Lab	270200220	270200220-0010	21	162.7906977	0.094247246
8		X	X	0.5		156 S. Central Rd	Indoor	Personal	1R-14571	Air	TEM-AHERA	DIRECT	20-Aug-02	0.0129	9	385	1	666	0.004979139	Mobile Lab	270200220	270200220-0011	20	172.2652885	0.099582787
9		X	X	0.5		156 S. Central Rd	Indoor	Personal	1R-14555	Air	TEM-AHERA	DIRECT	17-Aug-02	0.0129	10	385	1	149	0.020030175	Mobile Lab	270200212	270200212-0011	20	155.0387597	0.400603507
10		X		0.75	1	4000 Pipe Creek Rd	Outdoor	Stationary	1R-25513	Air	TEM-AHERA	DIRECT	14-Jun-05	0.013	5	385	1	1290	0.004591532	Mobile Lab	270500008	270500008-0003	12	184.6153846	0.05509330
11		X	X	0.5	1	Flyway Site	Outdoor	Personal	FL-00539	Air	TEM-AHERA	DIRECT	30-Aug-04	0.013	10	385	1	576	0.00514158	Mobile Lab	270400643	270400643-0008	15	115.3846154	0.077123397
12		X	X	0.5	1	KDC Bluffs	Outdoor	Personal	1R-08838	Air	TEM-AHERA	DIRECT	06-Sep-01	0.0129	10	385	1	615	0.004852839	Mobile Lab	ML01920	19496	20	155.0387597	0.097056786
13		X	X	0.5	1	KDC Bluffs	Outdoor	Personal	1R-08836	Air	TEM-AHERA	DIRECT	06-Sep-01	0.0129	10	385	1	661	0.004515123	Mobile Lab	ML01920	19494	19	147.2868217	0.085787332
14		X	X	0.5	1	KDC Flyway	Outdoor	Personal	1R-14215	Air	TEM-AHERA	DIRECT	24-Jul-02	0.0129	10	385	1	366	0.008154361	Mobile Lab	270200165	270200165-0001	18	139.5348837	0.146778498
15		X	X	0.5	1	KDC Flyway	Outdoor	Personal	1R-14217	Air	TEM-AHERA	DIRECT	24-Jul-02	0.0129	10	385	1	190	0.015707874	Mobile Lab	270200165	270200165-0003	15	116.2790698	0.235618115
16		X	X	0.5	1	Lincoln County Landfill	Outdoor	Personal	1R-23369	Air	TEM-AHERA	DIRECT	08-Oct-03	0.013	5	385	1	294	0.02014652	Mobile Lab	270301071	270301071-0003	51	784.6153848	1.027472527
17		X	X	0.5	1	Lincoln County Landfill	Outdoor	Personal	1R-24701	Air	TEM-AHERA	DIRECT	17-Mar-04	0.0121	10	385	1	150	0.021212121	Westmont	040404536	040404536-0002	31	256.1983471	0.657575758
18		X	X	0.5	1	Lincoln County Landfill	Outdoor	Personal	1R-23372	Air	TEM-AHERA	DIRECT	08-Oct-03	0.013	10	385	1	60	0.049358974	Mobile Lab	270301071	270301071-0006	22	169.2307692	1.085897436
19		X	X	0.5		Lincoln County Landfill	Outdoor	Personal	1R-24700	Air	TEM-AHERA	DIRECT	17-Mar-04	0.0121	10	385	1	101	0.03150315	Westmont	040404536	040404536-0001	19	157.0247934	0.598559356
20		X	X	0.5		Lincoln County Landfill	Outdoor	Personal	1R-21779	Air	TEM-AHERA	DIRECT	31-Jul-03	0.0125	10	385	1	320	0.009625	Mobile Lab	270300829	270300829-0003	19	152	0.182875
21		X	X	0.5		Lincoln County Landfill	Outdoor	Personal	1R-23653	Air	TEM-AHERA	DIRECT	21-Oct-03	0.0131	10	385	1	353	0.008325584	Mobile Lab	270301133	270301133-0007	11	83.96946565	0.091581429
22		X	X	0.5	1	Mine Rd	Outdoor	Stationary	1R-04984	Air	TEM-AHERA	DIRECT	05-Jun-01	0.0129	2	385	1	4515	0.00330509	Westmont	040107965	040107965-0003	22	852.7131783	0.072711976
23		X	X	0.5	1	Mine Rd	Outdoor	Stationary	1R-04985	Air	TEM-AHERA	DIRECT	05-Jun-01	0.0129	2	385	1	4950	0.003014543	Westmont	040107965	040107965-0004	17	658.9147287	0.051248323
24		X	X	0.5		Mine Rd	Outdoor	Stationary	1R-04748	Air	TEM-AHERA	DIRECT	29-May-01	0.0129	4	385	1	2879	0.002591608	Westmont	040107791	040107791-0003	14	271.3178295	0.036282516
25		X	X	0.5		Mine Rd	Outdoor	Stationary	1R-05526	Air	TEM-AHERA	DIRECT	29-Jun-01	0.0129	4	385	1	5040	0.001480405	Westmont	040110171	040110171-0006	12	232.5581395	0.017764358
26		X	X	0.5	1	Rainy Creek Bank	Indoor	Personal	1R-21565	Air	TEM-AHERA	DIRECT	18-Jul-03	0.0125	10	385	1	230	0.013391304	Mobile Lab	270300759	270300759-0014	24	192	0.321391304
27		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-23356	Air	TEM-AHERA	DIRECT	06-Oct-03	0.013	4	385	1	60	0.123397436	Mobile Lab	270301071	270301071-0001	54	1038.461538	6.663461538
28		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-22376	Air	TEM-AHERA	DIRECT	26-Aug-03	0.0125	5	385	1	62	0.099354839	Mobile Lab	270300916	270300916-0003	54	864	5.36516129
29		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-23338	Air	TEM-AHERA	DIRECT	07-Oct-03	0.013	5	385	1	228	0.025978408	Mobile Lab	270301067	270301067-0002	50	769.2307692	1.298920378
30		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-14519	Air	TEM-AHERA	DIRECT	15-Aug-02	0.0129	9	385	1	723	0.004586593	Mobile Lab	270200208	270200208-0001	49	422.0459563	0.224743061
31		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-22375	Air	TEM-AHERA	DIRECT	26-Aug-03	0.0125	10	385	1	264	0.011666667	Mobile Lab	270300916	270300916-0002	42	336	0.49
32		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-21808	Air	TEM-AHERA	DIRECT	31-Jul-03	0.0125	10	385	1	227	0.013568282	Mobile Lab	270300828	270300828-0002	40	320	0.542731278
33		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-14416	Air	TEM-AHERA	DIRECT	20-Aug-02	0.0129	10	385	1	673	0.004780523	Mobile Lab	270200218	270200218-0004	39	302.3255814	0.186830415
34		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14909	Air	TEM-AHERA	DIRECT	06-Sep-02	0.0129	10	385	1	344	0.008675661	Mobile Lab	270200262	270200262-0011	37	286.8217054	0.321006351
35		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-21783	Air	TEM-AHERA	DIRECT	26-Jul-03	0.0125	10	385	1	270	0.011407407	Mobile Lab	270300802	270300802-0003	33	264	0.376444444
36		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14518	Air	TEM-AHERA	DIRECT	20-Aug-02	0.0129	10	385	1	613	0.004868672	Mobile Lab	270200218	270200218-0006	33	255.8139535	0.160668186
37		X	X	0.5	1	Rainy Creek Rd	Outdoor	Stationary	1R-04586	Air	TEM-AHERA	DIRECT	06-Jun-01	0.0129	2	385	1	4507	0.003104323	Westmont	040107965	040107965-0005	31	1201.550388	0.096234013
38		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-22379	Air	TEM-AHERA	DIRECT	26-Aug-03	0.0125	10	385	1	264	0.011666667	Mobile Lab	270300916	270300916-0004	31	248	0.361666667
39		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14535	Air	TEM-AHERA	DIRECT	17-Aug-02	0.0129	10	385	1	61	0.048926166	Mobile Lab	270200213	270200213-0004	31	240.3100775	1.516711145
40		X	X	0.5	1	Rainy Creek Rd	Outdoor	Stationary	1R-04987	Air	TEM-AHERA	DIRECT	06-Jun-01	0.0129	4	385	1	4574	0.001596329	Westmont	04017965	040107965-0006	28	542.6356589	0.044697203
41		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14401	Air	TEM-AHERA	DIRECT	15-Aug-02	0.0129	10	385	1	689	0.004331634	Mobile Lab	270200208	270200208-0003	28	217.0542636	0.121285764
42		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14419	Air	TEM-AHERA	DIRECT	21-Aug-02	0.0129	10	385	1	284	0.010508769	Mobile Lab	270200225	270200225-0001	28	217.0542636	0.294245097
43		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-21807	Air	TEM-AHERA	DIRECT	31-Jul-03	0.0125	10	385	1	64	0.048125	Mobile Lab	270300828	270300828-0001	26	208	1.25125
44		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-21599	Air	TEM-AHERA	DIRECT	18-Jul-03	0.0125	10	385	1	225	0.013688889	Mobile Lab	270300763	270300763-0013	24	192	0.328533333
45		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14528	Air	TEM-AHERA	DIRECT	17-Aug-02	0.0129	10	385	1	65	0.045915325	Mobile Lab	270200213	270200213-0006	24	186.0465116	1.1019678
46		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14628	Air	TEM-AHERA	DIRECT	24-Aug-02	0.0129	10	385	1	360	0.008290267	Mobile Lab	270200237	270200237-0002	24	186.0465116	0.198966408
47		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14314	Air	TEM-AHERA	DIRECT	09-Aug-02	0.0129	10	385	1	630	0.004737295	Mobile Lab	270200188	270200188-0003	23	178.2945736	0.108957795
48		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-14413	Air	TEM-AHERA	DIRECT	21-Aug-02	0.0129	10	385	1	304	0.009817421	Mobile Lab	270200225	270200225-0005	22	170.5426357	0.215983272
49		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14525	Air	TEM-AHERA	DIRECT	16-Aug-02	0.0129	10	385	1	593	0.005032877	Mobile Lab	270200210	270200210-0004	21	162.7906977	0.105693419
50		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14521	Air	TEM-AHERA	DIRECT	16-Aug-02	0.0129	10	385	1	549	0.005436241	Mobile Lab	270200210	270200210-0001	20	155.0387597	0.108724813
51		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14733	Air	TEM-AHERA	DIRECT	28-Aug-02	0.0129	10	385	1	250	0.011937984	Mobile Lab	270200245	270200245-0012	20	155.0387597	0.23875969
52		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14387	Air	TEM-AHERA	DIRECT	13-Aug-02	0.0129	10	385	1	417	0.007157065	Mobile Lab	270200198	270200198-0002	20	155.0387597	0.143141321
53		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14533	Air	TEM-AHERA	DIRECT	17-Aug-02	0.0129	10	385	1	77	0.03875969	Mobile Lab	270200213	270200213-0002	19	147.2868217	0.736434109
54		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-14508	Air	TEM-AHERA	DIRECT	13-Aug-02	0.0129	10	385	1	342	0.008726587	Mobile Lab	270200198	270200198-0009	19	147.2868217	0.16580534
55		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14523	Air	TEM-AHERA	DIRECT	16-Aug-02	0.0129	10	385	1	219	0.013627636	Mobile Lab	270200210	270200210-0003	18	139.5348837	0.245301051
56		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14400	Air	TEM-AHERA	DIRECT	14-Aug-02	0.0129	10	385	1	413	0.007226383	Mobile Lab	270200203	270200203-0007	18	139.5348837	0.130074892
57		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-15074	Air	TEM-AHERA	DIRECT	14-Sep-02	0.0129	10	385	1	395	0.007555685	Mobile Lab	270200314	270200314-0001	17	131.7829457	0.128446663
58		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14397	Air	TEM-AHERA	DIRECT	13-Aug-02	0.0129	8	385	1	816	0.004571839	Mobile Lab	270200198	270200198-0010	15	145.3488372	0.068577576
59		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14550	Air	TEM-AHERA	DIRECT	21-Aug-02	0.0129	10	385	1	351	0.008502835	Mobile Lab	270200225	270200225-0003	15	116.2790698	0.127542563
60		X	X	0.5	1	Rainy Creek Rd	Outdoor	Personal	1R-14725	Air	TEM-AHERA	DIRECT	23-Aug-02	0.0129	10	385	1	317	0.009414614	Mobile Lab	270200232	270200232-0003	15	116.2790698	0.141222214
61		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14540	Air	TEM-AHERA	DIRECT	21-Aug-02	0.0129	10	385	1	81	0.036845631	Mobile Lab	270200225	270200225-0006	15	116.2790698	0.552684467
62		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-21600	Air	TEM-AHERA	DIRECT	31-Jul-03	0.0125	10	385	1	266	0.011578947	Mobile Lab	270300815	270300815-0002	13	104	0.150526316
63		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14530	Air	TEM-AHERA	DIRECT	24-Aug-02	0.0129	10	385	1	65	0.045915325	Mobile Lab	270200237	270200237-0004	13	100.7751938	0.596899275
64		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14303	Air	TEM-AHERA	DIRECT	08-Aug-02	0.0129	10	385	1	483	0.006179031	Mobile Lab	270200185	270200185-0003	13	100.7751938	0.080328053
65		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14651	Air	TEM-AHERA	DIRECT	29-Aug-02	0.0129	10	385	1	344	0.008675661	Mobile Lab	270200247	270200247-0017	12	93.02325581	0.10411033
66		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14723	Air	TEM-AHERA	DIRECT	23-Aug-02	0.0129	10	385	1	186	0.016045678	Mobile Lab	270200232	270200232-0001	12	93.02325581	0.192548137
67		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14395	Air	TEM-AHERA	DIRECT	13-Aug-02	0.0129	10	385	1	450	0.006632214	Mobile Lab	270200198	270200198-0007	12	93.02325581	0.079586563
68		X		0.75		Rainy Creek Rd	Outdoor	Personal	1R-14384	Air	TEM-AHERA	DIRECT	10-Aug-02	0.0129	10	385	1	611	0.004884609	Mobile Lab	270200191	270200191-0005	11	85.27131783	0.053730699
69		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14520	Air	TEM-AHERA	DIRECT	15-Aug-02	0.0129	10	385	1	61	0.048926169	Mobile Lab	270200208	270200208-0002	11	85.27131783	0.538187826
70		X	X	0.5		Rainy Creek Rd	Outdoor	Personal	1R-14509	Air	TEM-AHERA	DIRECT	14-Aug-02	0.0129	11	385	1	401	0.006786031	Mobile Lab	270200203	270200203-0001	11	77.51937984	0.074426337
71		X	X	0.5		Rainy Creek Rd - S Frontage	Outdoor	Personal	1R-26148	Air	TEM-AHERA	DIRECT	19-Aug-04	0.013	10	385	1	115	0.025752508	Mobile Lab	270400588	270400588-0002	49	376.9230769	1.26187291
72		X	X	0.5	1	Screening Plant	Outdoor	Personal	1R-05584	Air	TEM-AHERA	DIRECT	28-Jun-01	0.0129	7	385	1	838	0.005087787	Mobile Lab	ML01457	15561	54	598.0066445	0.274740522
73		X	X	0.5	1	Screening Plant	Outdoor	Personal	1R-05585	Air	TEM-AHERA	DIRECT	29-Jun-01	0.0129	10	385	1	63	0.047372954	Mobile Lab	ML01457	15562	17	131.7829457	0.805340224
74		X	X	0.5		Screening Plant	Outdoor	Personal	1R-05588	Air	TEM-AHERA	DIRECT	28-Jun-01	0.0129	7	385	1	836	0.005099959	Mobile Lab	ML01457	15563	16	177.1871539	0.081599347
75		X	X	0.5	1	Screening Plant	Outdoor	Stationary	1R-05349	Air	TEM-AHERA	DIRECT	20-Jun-01	0.0129	4	385	1	1728	0.004317847	Mobile Lab	ML01407	15152	15	290.6976744	0.064787711
76		X	X	0.5	1	Screening Plant Flyway	Outdoor	Personal	1R-09741	Air	TEM-AHERA	DIRECT	17-Aug-01	0.0129	8	385	1	839	0.004446503	EMSL	ML01753	ML01753-17837	33	319.7674419	0.146734762
77		X	X	0.5	1	Screening Plant Flyway	Outdoor	Personal	1R-14203	Air	TEM-AHERA	DIRECT	23-Jul-02	0.0129	10	385	1	316	0.009444603	Mobile Lab	270200164	270200164-0001	12	93.02325581	0.113335296

(a) It was assumed that 1/4 of the filter was used for each type of analysis already performed

Table 2
Selected Samples for Indirect Preparation

SAMPLE INFORMATION				ANALYSIS INFORMATION									RESULTS		
Index ID	Property Description	Media Description	Volume (L)	Lab	Lab Sample ID	Analysis Date	Analysis Method	Prep Method	GO Counted	GO Size (mm^2)	Primary Filter Area (mm^2)	Analysis Sensitivity (s/cc)	Primary Filter Loading (s/mm^2)	Total N LA Structures	LA Air Conc. (s/cc)
1R-31263	105 W. 2nd St	Outdoor, Stationary	1,376	Mobile Lab	270500592-0001	6/23/2005	AHERA	Direct	5	0.013	385	4.3E-03	200	13	5.6E-02
1R-31264	105 W. 2nd St	Outdoor, Stationary	1,474	Mobile Lab	270500592-0002	6/23/2005	AHERA	Direct	5	0.013	385	4.0E-03	246	16	6.4E-02
1R-29025	1511 Gallatin Ave	Indoor, Personal	61	Mobile Lab	270500410-0001	5/24/2005	AHERA	Direct	10	0.013	385	4.9E-02	223	29	1.4E+00
1R-29026	1511 Gallatin Ave	Outdoor, Stationary	131	Mobile Lab	270500410-0002	5/24/2005	AHERA	Direct	10	0.013	385	2.3E-02	292	38	8.6E-01
1R-14570	156 S. Central Rd	Indoor, Personal	665	Mobile Lab	270200220-0010	8/20/2002	AHERA	Direct	10	0.0129	385	4.5E-03	163	21	9.4E-02
1R-14574	156 S. Central Rd	Outdoor, Stationary	423	Mobile Lab	270200224-0001	8/21/2002	AHERA	Direct	10	0.0129	385	7.1E-03	178	23	1.6E-01
1R-14553	156 S. Central Rd	Indoor, Personal	149	Mobile Lab	270200212-0009	8/17/2002	AHERA	Direct	0.0129	10	385	2.0E-02	163	21	4.2E-01
1R-28513	4000 Pipe Creek Rd	Outdoor, Stationary	1,290	Mobile Lab	270500008-0003	1/14/2005	AHERA	Direct	5	0.013	385	4.6E-03	185	12	5.5E-02
FL-00539	Flyway Site	Outdoor, Personal	576	Mobile Lab	270400643-0006	8/30/2004	AHERA	Direct	10	0.013	385	5.1E-03	115	15	7.7E-02
1R-08836	KDC Bluffs	Outdoor, Stationary	661	Mobile Lab	ML01920-19494	9/6/2001	AHERA	Direct	10	0.0129	385	4.5E-03	147	19	8.6E-02
1R-08838	KDC Bluffs	Outdoor, Personal	615	Mobile Lab	ML01920-19496	9/6/2001	AHERA	Direct	10	0.0129	385	4.9E-03	155	20	9.7E-02
1R-14215	KDC Flyway	Outdoor, Personal	366	Mobile Lab	270200165-0001	7/24/2002	AHERA	Direct	10	0.0129	385	8.2E-03	140	18	1.5E-01
1R-14217	KDC Flyway	Outdoor, Stationary	190	Mobile Lab	270200165-0003	7/24/2002	AHERA	Direct	10	0.0129	385	1.6E-02	116	15	2.4E-01
1R-23369	Lincoln County Landfill	Outdoor, Personal	294	Mobile Lab	270301071-0003	10/8/2003	AHERA	Direct	5	0.013	385	2.0E-02	785	51	1.0E+00
1R-23372	Lincoln County Landfill	Outdoor, Personal	60	Mobile Lab	270301071-0006	10/8/2003	AHERA	Direct	10	0.013	385	4.9E-02	169	22	1.1E+00
1R-24701	Lincoln County Landfill	Outdoor, Stationary	150	Westmont	040404536-0002	3/17/2004	AHERA	Direct	10	0.0121	385	2.1E-02	256	31	6.6E-01
1R-04984	Mine Rd	Outdoor, Stationary	4,515	Westmont	040107965-0003	6/5/2001	AHERA	Direct	2	0.0129	385	3.3E-03	853	22	7.3E-02
1R-04985	Mine Rd	Outdoor, Stationary	4,950	Westmont	040107965-0004	6/5/2001	AHERA	Direct	2	0.0129	385	3.0E-03	659	17	5.1E-02
1R-21585	Rainy Creek Bank	Indoor, Personal	230	Mobile Lab	270300759-0014	7/18/2003	AHERA	Direct	10	0.0125	385	1.3E-02	192	24	3.2E-01
1R-04986	Rainy Creek Rd	Outdoor, Stationary	4,807	Westmont	040107965-0005	6/6/2001	AHERA	Direct	2	0.0129	385	3.1E-03	1,202	31	9.6E-02
1R-04987	Rainy Creek Rd	Outdoor, Stationary	4,674	Westmont	040107965-0006	6/6/2001	AHERA	Direct	4	0.0129	385	1.6E-03	543	28	4.5E-02
1R-14413	Rainy Creek Rd	Outdoor, Stationary	304	Mobile Lab	270200225-0005	8/21/2002	AHERA	Direct	10	0.0129	385	9.8E-03	171	22	2.2E-01
1R-14416	Rainy Creek Rd	Outdoor, Stationary	623	Mobile Lab	270200218-0004	8/20/2002	AHERA	Direct	10	0.0129	385	4.8E-03	302	39	1.9E-01
1R-14508	Rainy Creek Rd	Outdoor, Stationary	342	Mobile Lab	270200198-0009	8/13/2002	AHERA	Direct	10	0.0129	385	8.7E-03	147	19	1.7E-01
1R-14519	Rainy Creek Rd	Outdoor, Personal	723	Mobile Lab	270200208-0001	8/15/2002	AHERA	Direct	9	0.0129	385	4.6E-03	422	49	2.2E-01
1R-14725	Rainy Creek Rd	Outdoor, Stationary	317	Mobile Lab	270200232-0003	8/23/2002	AHERA	Direct	10	0.0129	385	9.4E-03	116	15	1.4E-01
1R-21599	Rainy Creek Rd	Outdoor, Stationary	225	Mobile Lab	270300763-0013	7/18/2003	AHERA	Direct	10	0.0125	385	1.4E-02	192	24	3.3E-01
1R-21793	Rainy Creek Rd	Outdoor, Personal	270	Mobile Lab	270300802-0003	7/26/2003	AHERA	Direct	10	0.0125	385	1.1E-02	264	33	3.8E-01
1R-22376	Rainy Creek Rd	Outdoor, Stationary	62	Mobile Lab	270300916-0003	8/26/2003	AHERA	Direct	5	0.0125	385	9.9E-02	864	54	5.4E+00
1R-23355	Rainy Creek Rd	Outdoor, Personal	60	Mobile Lab	270301071-0001	10/8/2003	AHERA	Direct	4	0.013	385	1.2E-01	1,038	54	6.7E+00
1R-05349	Screening Plant	Outdoor, Stationary	1,728	Mobile Lab	ML01407-15182	6/20/2001	AHERA	Direct	4	0 0129	385	4.3E-03	291	15	6.5E-02
1R-05584	Screening Plant	Outdoor, Personal	838	Mobile Lab	ML01457-15561	6/28/2001	AHERA	Direct	7	0.0129	385	5.1E-03	598	54	2.7E-01
1R-05585	Screening Plant	Outdoor, Stationary	63	Mobile Lab	ML01457-15562	6/28/2001	AHERA	Direct	10	0.0129	385	4.7E-02	132	17	8.1E-01
1R-07741	Screening Plant Flyway	Outdoor, Personal	839	EMSL	ML01753-17837	8/17/2001	AHERA	Direct	8	0.0129	385	4.4E-03	320	33	1.5E-01
1R-14208	Screening Plant Flyway	Outdoor, Stationary	316	Mobile Lab	270200164-0001	7/23/2002	AHERA	Direct	10	0.0129	385	9.4E-03	93	12	1.1E-01

APPENDIX D

Detailed Results for 31 Air Samples Analyzed
By Both Direct and Indirect Preparation

See Microsoft Excel Spreadsheet "AppD_I vs D Pilot Results.xls"

APPENDIX 5.2

MONTE CARLO SIMULATION OF DUST/SOIL RATIOS

The basic parameter of interest in this investigation is the ratio of the concentration of some chemical marker in dust compared to soil:

Ratio = C(dust) / C(soil)

If indoor dust were composed entirely of outdoor soil, and assuming there are no other sources of the chemical in indoor dust besides outdoor soil, then the default ratio would be expected to be about 1.0. However, based on studies at other sites (e.g., USEPA 1997, USEPA 2001), the concentrations of metals in soils are often somewhat enriched (usually by about 10%-30%) in the fine fraction (< 250 μm) compared to the bulk fraction of soil. Assuming that the fine fraction of soil is more likely to be transported into indoor dust by air and on clothing, the default ratio might then be expected to be on the order of about 1.1 to 1.3. In order to be conservative, a maximum ratio of 1.3 was assumed for this screening-level evaluation.

However, each measurement of concentration in soil and dust is subject to measurement error. In general, measurement errors are usually assumed to be approximately normal, and most analytical methods have between-duplicate variability on the order of 25% or less. Thus, for the purposes of this screening analysis, the ratio of concentration in dust *vs* soil was modeled as follows:

Ratio = NORMAL(1.3, 0.325) / NORMAL (1.0, 0.25)

Based on this model, a Monte Carlo simulation was performed in order to estimate the maximum soil/dust ratio that could be attributed to measurement error alone. The results are shown below:

Statistic	Ratio
Median	1.30
95^{th}	2.43
97.5^{th}	2.80

In order to minimize the exclusion of any data pairs that are potentially valid, the 97.5^{th} percentile was selected at the exclusion criterion for identifying samples with a probable (> 97.5%) indoor source other than soil. Therefore, any ratios greater than 2.8 (see Table 1) were considered unreliable, and were excluded from further calculations.

References

USEPA. 1997. Baseline Human Health Risk Assessment for the Murray Smelter Superfund Site - Site-Wide Evaluation. U.S. Environmental Protection Agency Region 8. May 1997.

USEPA. 2001. Baseline Human Health Risk Assessment - Vasquez Boulevard and I-70 Superfund Site, Denver, CO. U.S Environmental Protection Agency Region 8. August 2001; reissued December 2001.

Appendix 5.2
Table 1. Outliers

Location	Arsenic			Chromium			Copper			Lead			Nickel			Zinc		
	All Soil	Dust	Cd/Cs	All Soil	Dust	Cd/Cs	All Soil	Dust	Cd/Cs	All Soil	Dust	Cd/Cs	All Soil	Dust	Cd/Cs	All Soil	Dust	Cd/Cs
2098 Farm to Market Rd	4.7	3.3	0.70	8	44	5.2	11	33	2.9	8.9	34	3.8	8.9	20	2.2472	50	260	5.3
12 Granite Ave	6.4	24	3.78	12	54	4.7	15	77	5.1	13	29	2.3	8.7	15	1.7241	77	210	2.7
214 Colorado Ave	5.7	3.3	0.58	28	11	0.39	16	67	4.2	21	61	2.9	12	16	1.3333	59	220	3.8
1004 Wisconsin Ave	6.1	52	8.52	14	66	4.7	18	75	4.2	21	250	11.9	9.7	10	1.0309	52	310	6.0
500 Jay Effar Rd	4.6	4	0.87	9	18	1.9	14	63	4.7	10	42	4.1	12	81	6.75	50	240	4.8
2608 W. 2nd St Ext	4.4	5.7	1.31	10	20	2.1	15	62	4.3	14	38	2.8	9.7	16	1.658	59	290	5.0
791 Flower Creek Rd	7.0	3.6	0.52	11	10	0.95	22	30	1.4	16	19	1.2	8.9	8.6	0.9663	69	140	2.0
250 Farm to Market Rd	5.1	6.1	1.21	26	16	0.61	17	84	4.9	16	22	1.4	12.6	14	1.1155	60	180	3.0
224 Forest Ave	5.3	2.9	0.55	114	30	0.26	53	82	1.5	21	170	8.1	23.5	20	0.8511	104	410	4.0
290 Granite Ave	7.2	3.8	0.53	13	14	1.1	16	62	4.0	19	30	1.6	8.1	12	1.4815	74	380	5.1
393 Farm to Market Rd	5.0	5.1	1.02	20	12	0.60	36	42	1.2	38	35	0.92	10	16	1.6	150	170	1.1
35 McKay St	4.9	4.7	0.96	14	22	1.6	14	57	4.1	16	44	2.8	10.0	17	1.7085	58	240	4.1
1204 Nevada Ave	5.8	4.2	0.73	12	17	1.5	17	49	3.0	18	46	2.6	9.4	13	1.3904	160	290	1.8
408 Dakota Ave	8.9	15	1.69	19	18	0.95	21	160	7.6	315	91	0.29	9.0	15	1.676	390	410	1.1
222 W. Larch St	7.2	5.4	0.76	13	17	1.3	45	26	0.58	27	33	1.2	13.1	14	1.0687	156	260	1.7
3646 Highway 2 S	6.0	3.7	0.62	28	13	0.46	22	30	1.4	38	37	0.97	9.3	10	1.0753	120	400	3.3
275 Dawson St	6.4	5.4	0.84	8	10	1.3	14	20	1.5	26	29	1.1	6.8	8	1.1765	72	140	2.0
1026 Louisiana Ave	6.3	3.6	0.57	13	19	1.5	17	45	2.7	74	140	1.9	9.5	13	1.3684	81	260	3.2
113 Crest St	5.1	4.5	0.89	9.9	9.1	0.92	19	39	2.1	22	45	2.0	10	10	1	68	140	2.1
714 E. 6th St	4.8	3.8	0.80	15	11	0.74	19	32	1.7	27	24	0.91	10.1	9.7	0.9604	67	1300	19.4
N			20			20			20			20			20			20
Outliers			2			3			11			6			1			12
% Outliers			10%			15%			55%			30%			5%			60%

Units = mg/kg
All Soil = Average of yard/property and SUA soil samples
Dust = Interior house dust
Cd/Cs = Ratio of dust concentration to soil concentration
Non-detects taken at 1/2 the detection limit.
Data flagged as outliers; Cd/Cs ratio > 2.8

Appendix 10.1

Tasks 6-9: Applicable Libby Field Modifications (LFOs)

LFO-000086
LFO-000096

Record of Modification
to the
Libby Sampling and Quality Assurance Project Plan
Field Activities
LFO-000086

Instructions to Requester: **Fax to contacts at bottom of form for review and approval.**
File approved copy with Data Manager at the Libby Field Office (LFO).
Data Manager will maintain legible copies in a binder that can be accessed by LFO personnel.

Project QAPP (circle one): Phase I (approved 4/00) Phase II (approved 2/01)
Removal Action (approved 7/00) Contaminant Screening Study (approved 5/02)
Other (Title and approval date): Final Supplemental RI QAPP (SQAPP) (approved 6/24/05)

SOP (Number and Revision No.): NA

Other Document (Title, Number/Revision): NA

Requester: Terry Crowell Title: Field Team Co-Leader
Company: CDM Date: 8/29/05

Description of Modification: Dust sample 1-01358 having a sample result of 566 s/cm2, versus the stated result of >1,000 s/cm2, will qualify one property to be sampled for SQAPP Task 9.

Field logbook and page number modification is documented on: NA

Reason for modification: Due to the limited number of sample results qualifying properties for SQAPP Task 9, and in an effort to conduct several SQAPP tasks at the same property for cost-benefit purposes, the qualifying dust sample concentration was lowered.

Duration of Modification (circle one):
Temporary Date(s):
Resident address(es):

- If appropriate, attach a list of all applicable Index Identification numbers.

Permanent (complete Proposed Modification Section) Effective Date: 8/30/05

Proposed Modification to SQAPP (attach additional sheets if necessary; state section and page numbers of SQAPP when applicable): Page 20 of the document; Task 9 description of sampling locations. Dust samples used to select properties for this task have concentrations ≥566 s/cm2. The qualifying dust sample results are: 1D-02248 (1,425 s/cm2), 1D-02257 (1,483 s/cm2), and 1-01358 (566 s/cm2).

Technical Review and Approval: See attached email Date: 6/13/06
(Volpe Project Manager or designate)

EPA Review and Approval: See attached email Date: 6/5/06
(USEPA RPM or designate)

Crowell, Terry

From: Goldade.Mary@epamail.epa.gov
Sent: Monday, June 05, 2006 6:59 AM
To: raney@volpe.dot.gov
Cc: Crowell, Terry; churchill.peggy@epamail.epa.gov; murray.bill@epamail.epa.gov; luey.jim@epamail.epa.gov; miller.aubrey@epamail.epa.gov; obrien.wendy@epamail.epa.gov; goldade.mary@epamail.epa.gov
Subject: Field MODs

Attachments: pic22953.jpg

pic22953.jpg (20 KB)

Mark,
I have reviewed Terry's changes & signed the following field MODs: 64a, 64b, 74, 76-81, 86, 88. They are now only waiting for your signature.
I'm sending them via sail mail. Please let this dist list know when you have signed them and returned them to Terry.
Thanks,

(Embedded image moved to file: pic22953.jpg)

Crowell, Terry

..om: Raney, Mark [Mark.Raney@Volpe.dot.gov]
Sent: Monday, December 04, 2006 2:33 PM
To: Crowell, Terry
Cc: Goldade.Mary@epamail.epa.gov
Subject: RE: outstanding LFO mod forms

Terry,

FYI - I won't be able to make today's 5:00 pm EST call on the outstanding LFOs. However, I did want to let you know I found the package of Field Mods that Mary sent me this Summer. I signed LFOs 64a, 64b, 74, 76-81, 86, and 88 on June 13, 2006. I have the signed originals which I will send to you.

Mark.

-----Original Message-----
From: Crowell, Terry [mailto:CrowellTL@cdm.com]
Sent: Friday, December 01, 2006 11:13 AM
To: Raney, Mark
Cc: Goldade.Mary@epamail.epa.gov
Subject: outstanding LFO mod forms
Importance: High

Hi Mark – Mary and I will be talking at 3 pm Mountain time on Monday (12/4) to try to wrap up her review of the subject forms. There are still some forms awaiting Volpe review/approval – these are highlighted in the Mod Log attachment (second tab). Do you have time to take a look at these? Mary indicated that she had sent some of the signed originals on to you; let me know if you like me to email you any or all of these files.

I'm also attaching a couple of mods that I'm not sure you've seen – LFO000097 (attachment map in production) and LFO000098.

Please be aware that there is a question in the field pertaining to LFO000089 as to whether EPA wants to continue sampling visible vermiculite in SUAs.

Thank you,
Terry

Record of Modification
to the
Libby Sampling and Quality Assurance Project Plan
Field Activities
LFO-000096

Instructions to Requester: **Fax to contacts at bottom of form for review and approval.**
File approved copy with Data Manager at the Libby Field Office (LFO).
Data Manager will maintain legible copies in a binder that can be accessed by LFO personnel.

Project QAPP (circle one): Phase I (approved 4/00) Phase II (approved 2/01)
Removal Action (approved 7/00) Contaminant Screening Study (approved 5/02)
Other (Title and approval date): Final Supplemental RI QAPP (SQAPP) (approved 6/24/05)

SOP (Number and Revision No.): ASTM D-5755-95 with exceptions

Other Document (Title, Number/Revision): Phase 1 SQAPP (4/00); Dust SAP (8/7/03)

Requester: Terry Crowell Title: Field Team Co-Leader
Company: CDM Date: 4/17/06

Description of Modification: Dust samples were collected using two slightly different techniques for SQAPP Task 9 properties. Sample 1-01358 was collected on 4/10/00 by touching the surface of the carpeted material with the tip of the cassette nozzle in accordance with the technique in use at the time (under the Phase 1 SQAPP), while samples 1D-02248 and 1D-02257 were collected on 10/15/04 and 10/19/04, respectively, by hovering the nozzle immediately above the carpet surface (without making contact) in accordance with the Dust SAP Rev. 0 (8/7/03).

Field logbook and page number modification is documented on: NA

Implications of Modification: Slight differences in sample collection technique should be taken into account when using and evaluating SQAPP Task 9 data.

Duration of Modification (circle one):
Temporary Date(s): ____
Resident address(es): ____

- If appropriate, attach a list of all applicable Index Identification numbers.

Permanent (complete Proposed Modification Section) Effective Date: 8/30/05

Proposed Modification to SQAPP (attach additional sheets if necessary; state section and page numbers of SQAPP when applicable): Page 20 of the document; Task 9 description of sampling locations. Dust samples used to select properties for this task were collected under either the Phase 1 SQAPP or the Dust SAP.

Technical Review and Approval: ____ Date: ____
(Volpe Project Manager or designate)

EPA Review and Approval: see attached email Date: 12/5/06
(USEPA RPM or designate)

Crowell, Terry

From: Goldade.Mary@epamail.epa.gov
Sent: Tuesday, December 05, 2006 8:00 AM
To: Crowell, Terry
Cc: Raney, Mark
Subject: Re: revised LFO mod forms and requested attachments per phone call today

Attachments: SQAPPmodform_Fieldv5_LFO000089 rv1 (NR 3-6-06).doc; SQAPPmodform_Fieldv5_LFO000093 rv2.doc; SQAPPmodform_Fieldv5_LFO000096 rv2 (TC 4-17-06).doc; LFO000091 support table.pdf; LFO Mod Log update for Mary and Mark.xls

SQAPPmodform_Fieldv5_LFO000089... SQAPPmodform_Fieldv5_LFO000093... SQAPPmodform_Fieldv5_LFO000096... LFO000091 support table.pdf (8... LFO Mod Log update for Mary an..

Thank you, Terry! I've bundled LFO mods 89 thru 96 & 98 and sent to Mark today. Note that 97 will be signed once the list of props outside of OU4 is provided. I'm holding that one.

Also, on your mod form tracking spreadsheet, the changes to mod form page still needs to be updated based upon our discussion yesterday:
1) 2nd 7/1/03 entry: add missing phrase "project chemist"
2) delete 3rd entry & add: added "potential implications to modification"

Thanks,
Mary

"Crowell, Terry" <CrowellTL@cdm.com>
12/04/2006 04:24 PM

To: Mary Goldade/EPR/R8/USEPA/US@EPA
cc: "Raney, Mark" <Mark.Raney@Volpe.dot.gov>
Subject: revised LFO mod forms and requested attachments per phone call today

An updated Mod Log is also provided. Please let me know if you have any questions.

Thank you!
Terry(See attached file: SQAPPmodform_Fieldv5_LFO000089 rv1 (NR 3-6-06).doc)(See attached file: SQAPPmodform_Fieldv5_LFO000093 rv2.doc) (See attached file: SQAPPmodform_Fieldv5_LFO000096 rv2 (TC 4-17-06).doc) (See attached file: LFO000091 support table.pdf)(See attached file: LFO Mod Log update for Mary and Mark.xls)

APPENDIX 13.1

SELECTION OF AMBIENT AIR SAMPLES

Because TEM ambient air samples entered into the Libby2DB were not explicitly identified as such, it was necessary to use a multi-step process to separate out ambient air samples from other types of air samples that have been collected and analyzed at the site. Attachment 1 provides a list and brief description of the sequence of steps that were followed to identify the ambient air samples along with the Microsoft Access® query used to implement these selection steps in the Libby2DB. This selection procedure was applied to all air samples in the database that were collected from January 2000 through November 2004 (the date of the query at the time of the SQAPP). This date range represents the time when EPA initiated ambient air testing in Libby to the point when the database was queried in preparation for this report. Based on these criteria, a total of 404 ambient air samples were identified. Appendix 13.2 presents the detailed TEM results for all 404 ambient air samples.

ATTACHMENT 1
MICROSOFT ACCESS QUERY FOR IDENTIFYING AMBIENT AIR SAMPLES

INITIAL QUERY

The Libby 2 Database was intially queried by Volpe on January 11, 2005.

Basic SQL Query Restrictions:

Media = Air
Matrix = Outdoor
Personal/Stationary = Stationary
Sample QC Type = Field Sample (FS)
Sample Date = 1/1/2000 through 11/30/2004

SQL Code:

```
WHERE (((dbo_tblSample.SamplePersonalStationary)="Stationary") AND
((dbo_refSampleMedia.SampleMediaDesc)="air") AND
((dbo_refSampleMatrix.SampleMatrixDesc)="outdoor") AND
((dbo_refSampleQCType.SampleQCTypeAbbr)="FS") AND ((dbo_tblSample.SampleDateBegin)
Between #1/1/2000# And #11/30/2004#));
```

SQL Query Results:

A total of 10,052 unique samples were identified (encompassing 4,190 PCM analyses, 4,115 AHERA analyses, and 3,383 ISO analyses in the Libby 2 Database as of January 11, 2005).

ADDITIONAL RESTRICTIONS

A series of 23 steps were used to restrict the initial query results from 10,052 samples to the subset of 404 ambient air samples utilized in the 2005 report. These steps were applied by CDM in consultation with EPA (January 18-26, 2005).

*See Table 1 for Step Details.

Step Results:

A total of 404 unique samples were identified (encompassing 105 AHERA analyses and 351 ISO analyses in the Libby 2 Database as of January 11, 2005).

FINAL QUERIES

Because the Libby 2 Database is updated continually, analytical results for the 404 ambient air samples may have been added or modified since the query performed by Volpe on January 11, 2005. In order to capture the most recent analytical results for the 404 unique ambient air samples, TEM results for these samples were downloaded from the Libby 2 Database by SRC on September 19, 2005 into a Microsoft Access database.

Access Query Results:

For these 404 samples, a total of 146 AHERA analyses and 384 ISO analyses were available (as of September 19, 2005, including Lab QC analyses).

APPENDIX 14.1

SELECTION OF PERIMETER AIR SAMPLES

At the time of the SQAPP, soil cleanups had been performed at more than 350 locations in Libby. Because perimeter air samples entered into the Libby2DB are not explicitly identified as such, it was necessary to use a multi-step process to separate out perimeter air samples from other types of air samples that had been collected and analyzed at the site. Attachment 1 provides a description of the sequence of steps that were followed to identify perimeter air samples in Libby2DB, along with the Microsoft Access® query used to implement the selection procedure. This selection procedure was applied to all air samples in the database that were collected at the Libby site through February 10, 2006 (the date of the most recent database download at the time of the SQAPP). Based on these criteria, a total of 8,510 perimeter air samples were identified. Appendix 14.2 presents the detailed TEM results for all 8,510 perimeter air samples.

ATTACHMENT 1
DETAILS OF LIBBY2DB QUERY AND SELECTION CRITERIA

Initial Query Restrictions:
Based on a Libby 2DB download from 2/27/06

tblLocation -
LocationPropertyGroupCity = Libby

tblSample -
SampleMediaDesc = Air
SampleMatrixDesc = Outdoor
SamplePersonalStationary = Stationary
SampleQCTypeAbbr = FS (field sample)

tblAnalysis -
AnalysisMethod Like "TEM*"
AnalysisFilterStatus = NULL or "Analyzed"
AnalysisLabQCDesc = NULL or "Not a QA Result"

Query Output:
10,808 outdoor stationary air field samples collected from Libby with a valid TEM result (either ISO or AHERA)

N samples by year:

2000	1,879
2001	4,355
2002	856
2003	1,899
2004	1,031
2005	788
2006	0
total	**10,808**

Exclude Samples Based on Filters (see following table)

N samples by year (post-filter):

2000	1,412
2001	3,973
2002	535
2003	1,483
2004	555
2005	526
2006	0
total	**8,484**

ATTACHMENT 1 (cont.)
DETAILS OF LIBBY2DB QUERY AND SELECTION CRITERIA

Filter #	Filter Description	N samples excluded
1	Exclude samples identified as Ambient [a]	404
2	Exclude samples collected during Epperson & Loomis demolition [b]	139
3	Exclude SQAPP and Phase 2 samples	
3a	Index ID Not Like "SQ-*"	102
3b	Index ID Not Like "2-*"	49
4	Exclude Clean Room samples	
4a	LocationSampleGroupDesc <> "*clean room*" or "*cleanroom*"	19
4b	SampleLocationDesc <> "*clean room*" or "*cleanroom*"	63
5	Exclude Negative Air Filtration Unit (NAFU) samples	
5a	LocationSampleGroupDesc <> "*NAFU*"	208
5b	SampleLocationDesc <> "*NAFU*"	401
6	Exclude make-up air unit (aka: NAFU) samples	
6a	LocationSampleGroupDesc <> [c]	0
6b	SampleLocationDesc <> [c]	113
7	Exclude samples collected during vacuum truck removals	
7a	LocationSampleGroupDesc <> "*vac*"	0
7b	SampleLocationDesc <> "*vac*"	13
8	Exclude Automobile/Vehicle samples	
8a	LocationSampleGroupDesc <> "*vehicle*" or "*auto*"	4
8b	SampleLocationDesc <> "*vehicle*" or "*auto*"	0
9	Exclude Decontamination samples	
9a	LocationSampleGroupDesc <> "*decon*"	73
9b	SampleLocationDesc <> "*decon*"	58
10	Exclude Clearance samples	
10a	LocationSampleGroupDesc <> "*clear*"	60
10b	SampleLocationDesc <> "*clear*"	1
10c	SamplePrePostClear <> "*clear*"	105
11	Exclude Post-Cleanup samples	
11a	LocationSampleGroupDesc <> "*post*"	0
11b	SampleLocationDesc <> "*post*" (but not like "*fence post*")	0
11c	SamplePrePostClear <> "*post*"	37
12	Exclude Pre-Cleanup samples	
12a	LocationSampleGroupDesc <> "*pre*"	0
12b	SampleLocationDesc <> "*pre*" (but not like "*prevailing*")	0
12c	SamplePrepreClear <> "*pre*"	425
13	Exclude Decontamination samples	
13a	LocationSampleGroupDesc <> "*blank*"	0
13b	SampleLocationDesc <> "*blank*"	3
14	Exclude samples in which analysis and/or results are invalid (i.e., sensitivity cannot be calculated, key fields are left null)	21
15	Exclude "load-out" samples (associated with interior removals)	
15a	LocationSampleGroupDesc <> [d]	0
15b	SampleLocationDesc <> [d]	26
	TOTAL N SAMPLES EXCLUDED:	**2,324**

(a) See Ambient Air Report for a list of all Index IDs
(b) See Demolition Report for a list of all Index IDs
(c) "*make-up*" (also "make up", "makeup", "makup", "flake up", "negative", and "exhaust")
(d) "*load-out*" (also "load out", "loadout", "waste-out", "wasteout", "waste out", "bagout", "bag-out", "bag out")

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 1074562

SITE NAME: LIBBY ASBESTOS

DOCUMENT DATE: 10/23/2007

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☐ OVERSIZED
- ☑ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

1 CD - APPENDICES

Contact the Superfund Records Center to view available document.
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